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The Armored Ships of the United States Navy

Heavy Armor and Powerful Batteries Characterize American Battleships

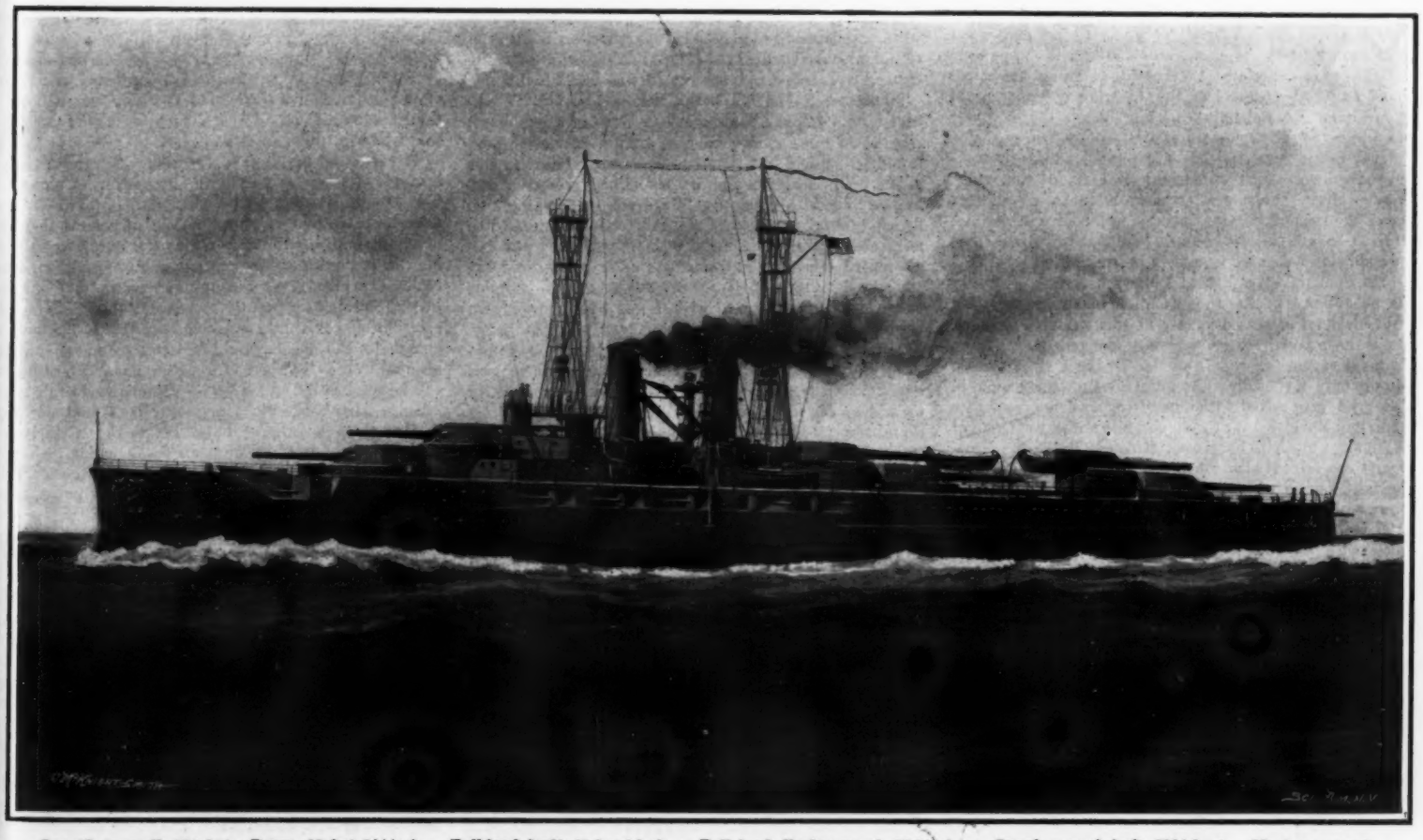
For several years past, during a period in which the two principal foreign navies have been devoting a considerable part of the total displacement of their fleets to high-speed cruisers of moderate armor protection, the United States Navy has been concentrating its efforts upon the upbuilding of a fleet of battleships, pure and simple. In running through the accompanying tables (see pages 331 to 334) showing the fighting strength of our navy, one looks in vain for a representative of that much-talked-of class of battle-cruisers of which the British and German navies have so many remarkable representatives. The battle-cruiser is built in recognition of the value of speed as one of the principal factors which go to make up the all-round efficiency of a fighting ship. Judging from the large number of these ships which have been constructed for some foreign navies, it is evident that the governments which possess them believe that they will play an important rôle in the tactics and strategy of future naval warfare. No doubt they will; and, in the case of a nation which stands ready to make liberal appropriations, sufficient to cover the annual programme as drawn up by its naval advisers, it would be good policy to make the appropriations necessary to include a certain number of these vessels in each annual budget.

In the United States, however, it has always been difficult to secure from Congress appropriations that are commensurate with our ever-increasing wealth and the multiplying obligations which our position as a great world power has laid upon us. In view of this fact, and acting under the conviction that the ultimate trial of strength in a naval war will occur when the main battleship fleets of two opposing powers are drawn up in line of battle, we have consistently followed the policy of putting the greater part of the displacement of our navy into ships of the first class, powerfully armed, and well protected, capable of holding their station in line of battle and of giving and taking the hard blows of a great decisive action upon the high seas.

From the time when we commenced, in the early eighties, to rebuild our navy upon modern lines, we have followed the traditional policy of this country by mounting upon our ships batteries that were considerably heavier than those carried by ships of the same size of other navies. Thus, although our first three battleships, the "Oregon," "Indiana" and "Massachusetts," had the moderate displacement of only 10,600 tons, they carried a heavier battery than contemporaneous British ships of three or four thousand tons greater displacement. Furthermore, throughout all the intervening years since that date, our ships, date for date, have carried heavier batteries and have been protected by heavier armor than the ships of any other navy. The "Oregon," on a displacement of 10,600 tons, carried 4 13-inch, 8 8-inch guns, and 4 4-inch rapid-firers, as against the 4 12-inch and 12 6-inch guns mounted on the British "Formidable," of 16,000 tons displacement. Again, the "Connecticut," 1904, with 4 12-inch, 8 8-inch and 12 7-inch guns on a displacement of 16,000 tons, may be compared with the 4 12-inch and 4 9.2-inch and 10 6-inch guns, carried by the British "Dominion" of 16,350 tons displacement.

To-day we are still holding the same relative position, but with the difference that the displacement of our ships is greater and the armor heavier. Thus, our "Nevada" of 27,500 tons displacement, carrying 10 14-inch and 21 5-inch guns, and armored with from 13 to 18 inches of Krupp steel, is a more powerful ship than the British "Orion," mounting 10 13.5-inch guns and 16 4-inch guns, and carrying armor from 10 to 12 inches in thickness.

The quality of our battleship fleet is most excellent; it is in numbers that we are deficient. In the spring of the present year, Great Britain had 29 ships of the dreadnought class built and building, with 5 projected, and Germany had 19 such ships under construction or completed, as against 13 for our navy. If Congress had not been parsimonious in the matter of appropriations, we would have had 15 such ships, but thanks to its action in cutting out, in two successive years, one ship from our most moderate programme of two ships a year, we are two ships below our standard of strength. The present year Congress should make the necessary appropriations for four ships with three as the minimum.



Length over all, 554 feet. **Beam,** 93 feet 2½ inches. **Full load draft,** 29 feet 8 inches. **Full load displacement,** 27,243 tons. **Speed,** normal draft, 20½ knots. **Maximum coal supply,** 2500 tons. **Radius,** at 10 knots speed, 8,000 knots. **Guns:** Twelve 50-caliber 12-inch; twenty-one 5-inch. **Torpedo tubes,** two 21-inch.

"Wyoming" and "Arkansas" of the United States Navy.

THE FOUR POWERFUL DREADNOUGHTS UNDER CONSTRUCTION IN AMERICAN YARDS.

Our Radium Resources*

Natural Resources Which Should Be Preserved for National Use

By Charles L. Parsons, Chief of the Division of Mineral Technology, Bureau of Mines

THE "wonders of radium," both fact and fable, have been treated so extensively in the scientific and public press that it is not my intention, nor is it at all necessary, to repeat them here. Rather it is my wish to-day to present to a body of men interested in the development of American mining the present commercial situation as regards radium and its ores, and to point out, so far as I may, some of those future developments that already begin to be more or less distinctively visible.

A bulletin on the radium, uranium and vanadium situation, by R. B. Moore, physical chemist in charge of the Denver office of the Bureau of Mines, and K. L. Kithil, mineral technologist of the Bureau, will appear within a few weeks and will contain much detail of interest to the mining industry. Last April an advance statement, authorized by the director, regarding this bulletin, brought out particularly the fact that practically all of the carnotite ore mined in the world in 1912 was shipped abroad and that this country was furnishing annually three times as much radium from its Colorado carnotite deposits as all the rest of the world put together. It was further pointed out that this material has been bought by European buyers at a price entirely incommensurate with its radium value and that efforts should be made to keep at home both the radium itself and the profits of its manufacture; also that too much stress could not be laid upon the extensive waste of valuable radium ore thrown on the dumps of mines and prospects —much of it under such conditions that it could never be recovered.

The publication of this statement has already resulted in an increase of at least 33 per cent in the price of carnotite ore, and European buyers are awakening to the fact that they must pay to the American miner a price nearer the actual value of his ore. Also, a much lower grade of ore is now marketable, for whereas six months ago ore containing 2 per cent uranium oxide was the lowest grade accepted by European buyers, agents of these buyers are now asking for and actually purchasing ore containing no more than half this content of uranium. Furthermore, the operators are taking more care in separating their low grade ore from the gangue and in protecting it from wind and weather. Moreover, old dumps are being sold and ore that a few months ago was thrown aside as valueless will be recovered from them.

As is well known to all of you, the popular belief has been that the chief source of radium is the mineral pitchblende, especially that obtained from the mines now under the control of the Austrian government at Joachimenthal, Bohemia, and pitchblende is the richest and most eagerly sought uranium radium ore. Outside of the ore in Austria, the only pitchblende deposits of any size are those in Gilpin County, Colorado, from which some thirty tons, more or less, have been produced since the mineral became valuable as a source of radium. The Denver papers recently announced that these pitchblende bearing mines have been acquired by Alfred I. du Pont, of Wilmington, Delaware, and it is greatly to be hoped that their exploitation under his direction will yield an increased supply of this valuable mineral. It is not, however, so generally recognized that the mineral carnotite, which, outside of the United States, occurs only in the Olray district of South Australia and in low grade ores mixed with ilmenite as a calcium carnotite (communicated by W. F. Hillebrand) under the name of Tyuyamyunite, in Ferghana, Russian Turkestan, low-grade ore mixed with ilmenite, is by far the more important source of radium. From the most authentic sources it can be definitely stated that the Australian and Russian deposits do not compare in extent or richness with our own. The American carnotite is accordingly the largest source of radium at the present time, and at least four times as much radium was mined in America in the form of carnotite in 1912 as has been produced from Colorado pitchblende since it was first discovered in that State.

Outside of carnotite and pitchblende, the only other known source of radium is the mineral autunite. The autunite deposits of Portugal have probably furnished a few milligrams to commerce, and from the Mt. Painter deposits in South Australia a few tons of autunite-bearing ores have been shipped to London.

American carnotite is found chiefly in Montrose and San Miguel counties, Colorado, and in Utah, northwest of these counties. The Utah deposits are at Green River, Table Mountain, Richardsons, Fruita, Moab, and some sixteen miles southeast of Thompsons. The ores of these deposits are of a lower grade than those of the Paradox Valley, but they are nearer to the railroads and transportation costs are much less. The Green River deposits have apparently become regular producers. In Colorado, prospects have been opened at Coal Creek, fourteen miles north of Meeker, and at Skull Creek, sixty-five miles west of Meeker, but the richest of all American carnotite localities and, indeed, the richest known radium-bearing region in the world is that of the Paradox Valley, extending from Hydraulic on the north to the McIntyre district on the south.

Geologists are now in the field making a special study of these carnotite ores with special reference to their occurrence and origin, of which altogether too little is now known. In the Paradox region, the deposits seem to lie invariably just above the fine-grained La Plata sandstone. This rock is usually exposed high on the sides of the canyons, some of which are excelled in extent and in natural beauty by only the Grand Canyon itself. In a few instances, as at Long Park and Club Ranch, the deposits are only a few feet under the surface, the higher formations having been eroded; but for the main part, the stratum in which the carnotite occurs, when not entirely eroded, is deep below the surface of the mess. Accordingly prospecting is mainly carried on along the sides of the canyons, and where vanadium and uranium stains are seen upon the rock the prospector blasts his tunnel in the hope of developing a pocket of the ore. The fact that the ore occurs in pockets renders prospecting uncertain, and there appears to be no present hope of insuring a successful search for pockets that are not exposed, or do not happen to be near the surface. Although it is probable that many other pockets of carnotite occur at the same geologic horizon, their discovery, except where the ore-bearing stratum has been exposed by erosion, appears at present to be an almost hopeless task. The eroded sides of the canyons have been prospected again and again, but now claims are still being opened and are being sold by the prospector to the larger companies or operators who mine the ore. In such a sale the prospector and the purchaser both take a decided risk, for at present no method is used to determine the extent of the ore in the pocket other than the "prospector's hole."

As few of the prospectors of the west are acquainted with carnotite and pitchblende, the following description of the ores has been issued from the Denver office of the Bureau of Mines and is sent to all who make inquiry:

Radium is found with uranium minerals only. Wherever uranium exists, radium is also found in the mineral; and where there is no uranium, radium has never been found. Uranium and therefore radium are found in this country in carnotite and its associated minerals, and in pitchblende. Carnotite is a lemon-yellow mineral, usually found in pockets of sandstone deposits. The mineral may be in the form of light yellow specks disseminated through the sandstone, or as yellow incrusations in the cracks of the sandstone; or may be more or less massive, associated with blue, black, or brown vanadium ores.

Pitchblende is a hard, blue-black ore that looks something like magnetite, but is heavier. It is found in pockets and veins in igneous rocks. This mineral is not nearly as widely distributed as carnotite. Occasionally it is found associated with an orange mineral called gummite.

The best way to test these ores is to wrap, in the dark, a photographic plate in two thicknesses of black paper. On the paper lay a key and then, just above the key, suspend two or three ounces of the ore, and place the whole in a light-tight box. Pressure of the ore on the key and plate should be avoided. After three or four days, develop the plate in the ordinary way; and if the ore is appreciably radio-active, an image of the key will be found on the plate.

The United States Bureau of Mines, 502 Foster Building, Denver, Colorado, will be glad to receive any samples of ores giving promise of containing radium and associated rare minerals, as indicated by the test above described. Though it cannot undertake to make chemical analyses or assays of such minerals for private parties, it will indicate the advisability of further examination.

The Colorado carnotite deposits were apparently first noted as far back as 1881, when Andrew J. Talbert mined some of the ore and sent it to Leadville, where it was reported as carrying $5 in gold per ton. This must have been an unusual ore, as the carnotite now found does not carry the precious metal. In 1912 the American Rare Metals Company acquired the mill of the Dolores Refining Company and is now operating it, with the special purpose of obtaining radium from the ores. The first attempt to extract radium in this country appears to have been made by the Rare Metals Reduction Company, under the management of Stephen T. Lockwood, of Buffalo, N. Y. In September, 1900, Mr. Lockwood brought back from Richardson, Utah, samples of carnotite ore and in 1902 he published in the *Engineering and Mining Journal* of September 27 the first radiographic plate from products of American carnotite. In June, 1902, he received 500 pounds of specially picked high-grade ore from Richardson, Utah, and in May, 1903, as a result of experimental work on this ore, he incorporated what was probably the first American company to operate a plant to produce radium as one of its products. In October, 1903, the first experimental plant was constructed and in April, 1904, the first 17-ton car of ore reached Buffalo from Richardson, Utah. The company obtained a fair percentage of extraction, but the ore proved to be too low grade and the Richardson deposits were abandoned. No radium in concentrated form was put upon the market, although barium sulphate concentrates were produced.

The General Vanadium Company, which, with the Radium Extraction Company, is a subsidiary of the International Vanadium Company of Liverpool, England, was formed in 1909 and began work in 1910, the same year that the Standard Chemical Company of Pittsburgh, Pa., entered the field. Since that time these two companies have been engaged in mining carnotite. The ores from the General Vanadium Company have been shipped almost entirely abroad, while the Standard Chemical Company has shipped several hundreds of tons of carnotite to its works at Canonsburg, Pa. While it was stated at the time of the advance announcement of the bulletin to be issued by the Bureau of Mines, that one American Company had actively entered into the production of radium, no actual sale of American produced radium could be authenticated. Since that time, however, the Standard Chemical Company has entered the American markets.

Besides the American Rare Metals Company and the Standard Chemical Company, a third company—the Radium Company of America, with mines near Green River, Utah—has undertaken the production of radium in its plant at Sellersville, Pa. There is, therefore, every reason to hope that more and more of our ores will be worked up at home.

Besides the companies already mentioned, a number of independent operators mine and ship carnotite from the Paradox region and for the main part send their ores to Hamburg, Germany.

The costs of mining, and especially of transportation, are an important factor in the marketing of carnotite. The Green River deposits have a distinct advantage over the Colorado deposits in this respect, as they are nearer the railroad, but, as their ores do not average so high in uranium, this advantage is more apparent than real. The present costs of mining, sorting and sacking in the Paradox apparently vary from about $28 to $40 per ton. To this must be added an $18 to $20 hauling charge to Placerville, and, in most instances, an additional charge for burros from the mines to points that can be reached by wagon. The freight rate from Placerville to Hamburg, via Galveston, is $14.50 per ton, so that the average cost at present to the miner laying down his ore at the European markets approximates $70 per ton. The selling price varies with the uranium content, but is by no means proportional thereto, since a premium is always paid for rich ores. Very recently, however, a decided improvement has taken place and for 2 per cent ore, the price is now around $2.50 per pound for the contained uranium oxide, with an allowance of about 13 cents per pound for the vanadium oxide content, so that the 2 per cent ore will now bring in Hamburg about $95 per ton. One per cent ore is now salable, but unless this ore is taken from the dump, so that the mining cost may be disregarded, it will scarcely bear present transportation charges from the Paradox, although it is more than probable that it will be soon shipped regularly from the Utah field.

A price of $95 at Hamburg for 2 per cent ore leaves a fair margin of profit to the miner, as mining profits go, but when it is considered that this price represents only a little over one-sixth of the value of the radium content of the ore and that from this fraction of the value the American miner has to meet the outlay represented by the investment, by mining costs, transportation and assay costs and by losses in transit, it seems scarcely just that nearly five-sixths of the value should go to

*Address to the Sixteenth Annual Convention of the American Mining Congress, Philadelphia, October 20–24th, 1913.

foreign manufacturers of radium, especially when the fact is considered that radium can be produced much more readily from carnotite than from pitchblende. There are two ways of reducing this difference between the actual value of the ore and the price that the miner receives. One is to hold our American ores for a higher price, and the second is to manufacture radium at home.

Large wastes are still taking place in the mining of carnotite, owing to the inability of the low-grade ores to bear transportation charges. As has already been pointed out, however, a distinct improvement in this respect has taken place within the last few months. The miners are beginning to realize the value of their old dumps and are attempting to save the low-grade, non-shipping ore in such ways as will render its marketing possible when prices advance. The Bureau of Mines has done everything it can to impress the necessity of this truest kind of conservation upon the mine operator.

In addition, there is prospect that most of the low-grade ores can be successfully concentrated by mechanical methods and experiments at the Denver office of the Bureau of Mines indicate that a concentration of four to one can be obtained. In this concentration, however, there are losses which would be prevented by chemical concentration, but at the present time it costs more to ship the necessary chemicals to the mines than it does to ship the ores to places where these chemicals can be cheaply obtained. It would appear, however, that mechanical concentration can save at least one half of the material that is now going to waste.

Although, until recently, the manufacture of radium from carnotite has been carried on almost wholly in France and Germany, there is no good reason why our American carnotite should not be treated at home. Carnotite is much more easily treated than pitchblende and the essential features of methods for its chemical treatment are well known, although much of the mechanical detail of operation has been kept secret. As the mechanical requirements, however, as those which any well-grounded chemical engineer should be able to solve, there seems to be no good reason why any of our carnotite ores should be shipped abroad, even at two or three times the present market price of the material.

As before stated, the essential features of chemical methods of extracting radium from its ores are well known. As regards the principles involved, the methods have advanced little beyond the original method published by Debierne.

The methods for carnotite may be described best in the words of Soddy, in an extract from "The Chemistry of the Radio Elements," by Frederick Soddy, page 55, published in 1911 by Longmans, Green & Co.

"The most important operations in the working up of radium-containing materials are the solution of the materials, consisting usually of insoluble sulphates, and the separation of the halogen salts of the alkaline-earth group in a pure state, followed by their fractional crystallization. The first operation is usually effected by vigorous boiling with sodium carbonate solution, filtering and washing free from sulphate. This is the well-known reaction studied dynamically by Guldberg and Waage, whereby an equilibrium is attained between the two pairs of soluble and insoluble sulphates and carbonates. Naturally the greater the excess of sodium carbonate the larger the proportion of insoluble sulphate converted into insoluble carbonate. In this operation it is advisable not to wash at once with water, but with sodium carbonate solution until most of the sulphates are removed, as thereby the reconversion of the carbonate back into insoluble sulphates is largely prevented. In dealing with crude materials—for example, the radium containing residues from pitchblende—it is often advantageous to precede this operation by a similar one, using a sodium hydrate solution containing a little carbonate, which dissolves part of the lead and silica present. The carbonates, washed free from sulphates, are treated with pure hydrochloric acid, which dissolves the alkaline-earths, including radium. From the solution the latter may be precipitated as sulphate by sulphuric acid and reconverted back into carbonates as before, or sometimes more conveniently they may be precipitated directly as chlorides by saturating the solution with hydrogen chloride. This is a very elegant method of great utility in the laboratory, for the most probable impurities, chlorides of lead, iron, calcium, etc., remain in solution and only the barium and radium chloride are precipitated, practically in the pure state, ready for fractionation."

The price of radium appears for some time to have been holding steady at about $120 per milligram of radium metal. This does not mean that the material is bought in the elementary condition, but that the radium chloride and radium bromide, which are on the market, are paid for on the basis of the metallic radium they contain. This method of payment is a distinct advance over the old method of paying the same price indiscriminately for the chloride or bromide. This price of $120 per gram of the metal is equivalent to approximately $91,000 per gram of radium chloride ($RaCl_2$), or $70,000 per gram of anhydrous radium bromide ($RaBr_2$). Whether this price will rise, fall, or remain stationary can not be predicted. There is no question that there is to be an increased radium production and that meso-thorium is also coming upon the markets in increasing quantity, but the use of and demand for radium are apparently developing at an even greater rate. Furthermore, the supply of the material is limited and no large resources are in sight. Only one estimate has been published of the total quantity of radium in the Colorado carnotite deposits, and that was 900 grams. This estimate is at least five times as large as has been made by any employee of the Bureau of Mines, reckoning all known deposits in the whole American field, even including material too low grade to be marketable. Besides the radium, the uranium and the vanadium present in carnotite are available assets, and recent developments indicate that all the uranium produced will soon be readily sold, while it is well known that there is a ready market for vanadium for vanadium steel.

The value to the public of these deposits is, however, not to be measured in dollars and cents. The value of the radium output of America will never compare with that of several of our common metals. The total value of the radium in the world's output of radium ores in 1912 was little more than $1,000,000. Accordingly, the value must ever be reckoned in what it can accomplish for the public knowledge and the public weal. No certain prediction can be made of the ultimate value of radium, or of its possible applications to science or medicine, but enough has been done to show that radium is worthy of the fullest investigation by our highest scientific and medical authorities. Developments in its application to medicine are coming fast. The foreign medical press contains many apparently authentic reports of cures by its use. Interesting developments are also under way in America, and those who have had the largest personal experience in its use are most enthusiastic over its future application. The public may soon look to important publications from leading American authorities, who have had real experience in radium therapy. It is to be greatly regretted that, owing to the high price of the material, only three or four American surgeons have, so far as the Bureau of Mines is informed, been able to use it in quantities sufficient for the drawing of decisive conclusions. In the progress of the future applications of radium to the curing of disease, nothing is more to be feared than its use in nostrums of every kind. The "wonders of radium" have been so extensively exploited in the public press that already the name is being employed as a psychological agent in advertisements of all kinds of materials, many of which contain no radium at all, or, if this element is indeed present, in such small quantities that no therapeutic value can be expected. As bearing on the need of further experiment, attention is called to the fact that the concentrated action of large quantities of radium may effect cures that have been impossible with the smaller amounts heretofore available to the medical profession. It is doubtful if there is at the present time in the hands of the medical profession of America more than a single gram of this rare element, and the results of investigations soon to be published will show that the concentrated action of the gamma rays from several hundred milligrams arrest certain forms of cancer and other malignant growths when smaller quantities are without beneficial effect. It is highly important that the medical profession should also have some guarantee of the material they purchase, even if it is purchased in small quantities, and I am glad to note that the United States Bureau of Standards is preparing to standardize radium preparations. *As several frauds in the sale of radium have already been perpetrated upon American physicians, they should all require that the quality of the material purchased should be certified under conditions which prevent error.*[1]

In closing, I take pleasure in saying that I am authorized by the Director of the Bureau of Mines to announce that a co-operative agreement has been entered into with the newly organized National Radium Institute, whereby the Bureau obtains the opportunity of a scientific and technological study of the mining and concentrating of carnotite ores and of the most efficient methods of obtaining radium, vanadium, and uranium therefrom, with a view to increased efficiency of production and the prevention of waste.

The Institute has no connection with the mining of pitchblende, details of which recently appeared in the Denver papers. It has, however, obtained the right to mine 27 claims in the Paradox Valley region, among which are some of the best mines in this richest radium-bearing region of the world. Nearly 100 tons of high-grade carnotite have already been procured. Under the agreement with the Bureau of Mines, the technical operations of the mines and mill are to be guided by the scientific staff of the Bureau. Work will begin in an experimental plant to be erected in Colorado, using entirely new methods developed at the Denver office of the Bureau of Mines. Concentration experiments also will be conducted in the Paradox, probably at the Long Park claims, and if successful will be applied to reducing the wastes that now take place. Within a year at most, the mill operations should make results certain and the extraction of ore and production of radium will then be continued on a larger scale. The separation of uranium and vanadium will also be studied, a contract having already been signed for all of these by-products that may be produced. All processes, details of apparatus and plant, and general information gained will be published for the benefit of the people.

The Institute is supplied with sufficient funds to carry out its plans.

The Institute has been formed for the special purpose of procuring enough radium to conduct extensive experiments in radium therapy with special reference to the curing of cancer. It also expects to carry on investigations regarding the physical characteristics and chemical effects of radium rays and hopes in time to be able to assist or perhaps even duplicate the effects of these rays by physical means.

Actual experience, especially of the Institute's President, in the application of the 650 milligrams of radium and 100 milligrams of meso-thorium already in his possession, have led him and his associates to believe that with larger supplies many of the variables that cannot now be controlled may be fully correlated, and that radium may become the most effective agent for the treatment of cancer and certain other malignant diseases. Important results have already been obtained by using high concentration of the gamma rays of radium with the alpha rays entirely cut off and the beta rays largely eliminated. Hospital facilities in both Baltimore and New York are already supplied.

The activities of the Institute are sure to be of benefit to the prospector and miner by providing a greater demand for his already rare ore; to the plant operator by developing methods and by creating a larger market for his product; and to the people by assisting, and possibly by succeeding, in controlling the most malignant of diseases. The radium produced is intended for the Institute's own use and will consequently remain at home.

The Bureau of Mines is especially fortunate in the opportunity to co-operate in the technological features of the work of the Institute.

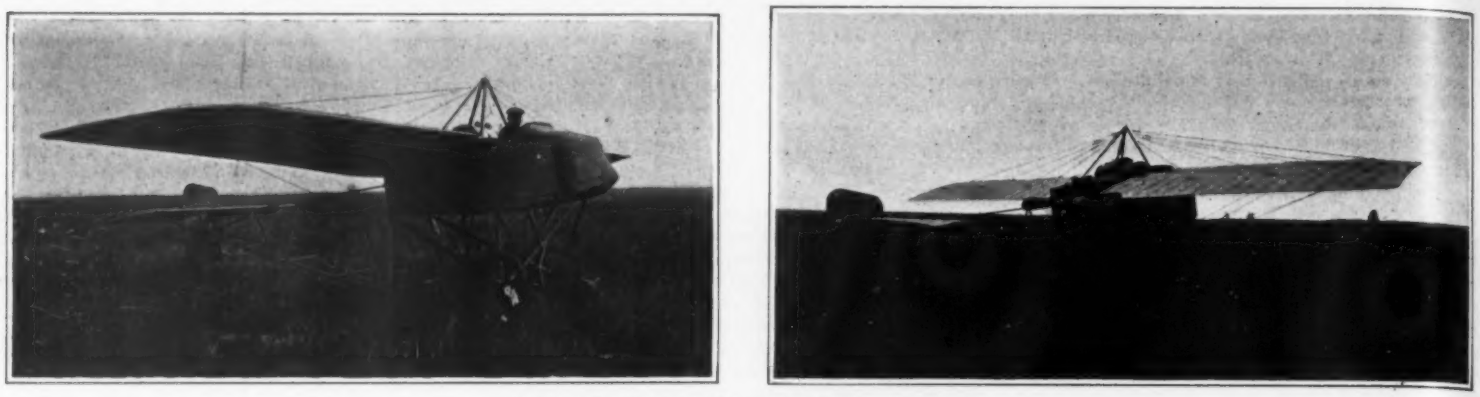
[1] The italics are ours.—Ed.

The Consumption of Paper

Paper may be divided into three great classes—viz., high-class, ordinary paper for current uses, and paper for folding. It is certain that the consumption of the higher classes of paper is increasing, but very slowly, and this industry will always find sufficient raw material for its requirements, more especially as the scale of its prices is very elastic. The same cannot be said for the second class, that of paper for ordinary use; that is to say, paper intended for daily uses, such as newspaper editions, prospectuses, and generally speaking for all printed and written matter. It is this consumption that is continually increasing, and whose needs and demands of paper are ever becoming more and more imperious. It is in order to fulfill these requirements, considerably increased by the use of rotary printing machines, with a large output, that the stationery industry has also been obliged to create paper machines of great width and great speed, which can turn out as much as forty or fifty tons of paper in twenty-four hours; it is also for this kind of paper the forests are pillaged. When there is no longer a sufficient quantity of wood to be had, with what will these paper-mills be fed? At that moment the only wood remaining will be that obtainable from the annual growth of forests reserved and arranged for periodical cuttings, and the stationery industry will have to share them with other industries. M. Henry Montessus de Ballore, in his interesting technical work, tries to solve the question concerning the future resources in raw material of paper manufacture. He has drawn up a list of those materials of which the cellulose could be used for the manufacture of paper.

Besides wood, to feed the paper mills in the future, we have: Plants that grow spontaneously, bamboo, papyrus, alfa; the refuse of various industries, rags, cables, cords, strings; the refuse of spinning-mills, cotton, linen, hemp, jute, phormium; the refuse of agriculture, wheat and rye straw, oat and rice straw, the stalks of Indian-corn, and the refuse of the sugar cane.

M. de Montessus de Ballore has specially studied each of these matters, their treatment, their yield, and the rise of the pastes obtained; lastly, he has noted some plants that, at least for the present, appear to have only a very restricted future in the paper industry.—*Chemical News.*



Front and rear views of the Borel military aeroplane.

The 1913-14 Borel Monoplane; Military Type

By John Jay Ide

THE new military type Borel, which made its first appearance last June, has caused quite a sensation in France. Heretofore most aeroplanes have been designed with aerodynamic efficiency as the sole end in view. If they were to be used by the army some modifications from the standard type were indeed introduced, but generally only during the period of testing, or at best in the final stages of construction. In the design of this machine, on the contrary, the military desiderata were determined upon in advance and were given precedence over the qualities governing the efficiency of the machine as an aeroplane.

In addition to safety, speed, and useful load supported, what are the qualities especially desirable in a military aeroplane? They are a wide angle of vision to facilitate the work of reconnaissance, and the ease with which bombs may be thrown or a machine gun operated. In consequence the pilot and observer have been placed side by side in advance of the wings in a commodious fuselage. The transparent windshield is of a concave form projecting most of the wind over the head or to the side of the observer, thus making it possible to study the ground or maps in comfort.

Underneath the mast, immediately behind the seats, the fuel and oil tanks are situated. In their rear the 80 horse-power Gnôme motor is placed. It is not overhung, there being a ball bearing between it and the propeller.

It is unnecessary to draw attention to the excellence of the position of the propeller behind the wings, since it has been demonstrated that this situation is better from an aero-dynamic standpoint than one in front of the planes. For military purposes the rear position is almost essential, as otherwise observation and bomb throwing, or firing, are very much hampered.

The empennage is connected to the fuselage by three steel tubes the upper one of which passes through the hub of the propeller, while the two lower ones are spaced far enough apart to allow for the passage of the blades. The main tubes are united by a series of triangles, thus preventing possible distortion. There is no danger of the propeller hub seizing on the tube which passes through it as it is constantly bathed in oil from the engine crank case. The front ends of the lower tubes are joined to the rear of the twin skids.

The control wires for the elevator and rudder pass through the tubes, thus being well protected from damage. Another advantage of enclosing the wires is that in case of one breaking it cannot come in contact with the propeller. The wires are in duplicate as in many of the better aeroplanes now manufactured. The other features of the machine are typical of Borel practice.

The new military model piloted by Daucourt made its first trials on the 14th of June. They were entirely satisfactory. Notwithstanding the weight of the passenger and enough fuel and oil for three hours flight the machine left the ground very quickly and effected numerous flights exhibiting an extraordinary ease of conduct and stability.

The characteristics of the new machine are: Length 23 feet, span 38 feet 6 inches, total height 9 feet, 10 inches, weight (empty) 924 pounds.

How a Basement Story Was Added to a Mill

By James Chittick

I ONCE encountered a somewhat awkward problem, which, with the manner in which it was met, was as follows:

We had bought a group of mills and were remodeling them to suit our purposes, and in part of the space it was our intention to house a silk throwing plant.

Three buildings, erected at different times, and joined together, made three sides of a hollow square. Under the building at one end was a cellar, having about 8 feet of head room, which had been used for coal and other storage, and under the central building of the group there was no cellar at all.

We desired to put a silk spinning plant in this cellar of the end building, so we cleared it out, opened long area-ways along the sides from which we pierced the walls with numerous windows, glazed with prismatic glass, and concreted the floor, and, in short, turned it into a clean, well lighted, and (barring the very scant head room) excellent place for the purpose intended.

Some additional space, however, was required for certain work in connection with the department, work such as the soaking, whizzing, steaming, and drying of the silk, and in which water and steam were required, and for which purposes a basement location was desirable.

A situation under the central section of the mills would have been very convenient for this, but here there was no cellar, so, in spite of the fact that the foundations of the walls of this building did not go far below the ground, I determined to have one made.

This building was some 80 feet long by 23 feet wide inside, having two stories with a flat roof, and the walls were 12 inches thick and of good brick, well laid.

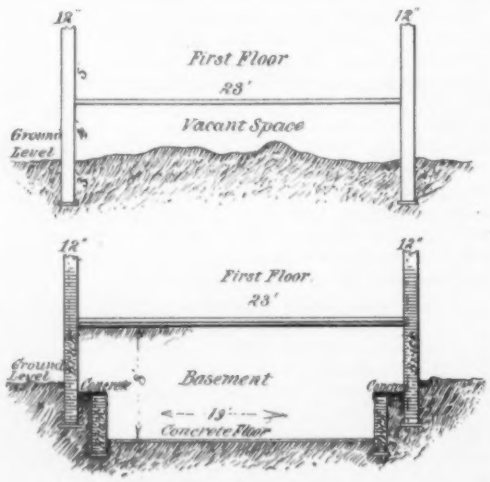
The foundation walls extended down three feet below the surface, and the ground they rested on was a fairly firm loam with some clay. There was a space of 4 feet between the floor of the lower story and the ground.

It occurred to me that if we built a retaining wall inside of the outer walls, we would be able, safely, to dig out a cellar to the depth of the one that was to connect with it, in which, as stated, we had 8 feet of head room, so that it would be requisite for the floor of the new cellar to be 4 feet below the ground level.

I present two diagrams herewith, the first of which shows the conditions of the premises, as they existed. The second diagram shows the alterations that we made, excepting that certain area-ways and windows which were constructed in connection with it, and which are referred to later, have been omitted from the drawings.

We first dug out the major portion of the earth from the inside, being careful not to disturb it near to the foundations, and we then dug away for a short distance, parallel with the foundations, sufficient earth to allow us to build a section of a brick wall, 12 inches thick, and located 12 inches away from the main wall, so that there was 1 foot in width of the solid earth between them, and as the building of the wall proceeded all open space between the wall and the earth was tightly packed with soil. This new wall was 4 feet high, 3 feet of which was above the level of the floor that was to be made, and the other foot below it.

As soon as this few feet was constructed, some more earth was dug away and another length was built on, and so we proceeded right round the walls.



By working it in piece by piece, we avoided any risk of the foundations settling, or the earth under them slipping. In laying the brick, portland cement was used instead of mortar.

After the retaining wall was completed, the top of the 12 inches of earth separating it from the old wall was scraped away to a depth of some 6 inches, and in this cavity was laid concrete, and then a smooth coating of cement was laid over all, extending from the old wall to the inner edge of the new wall, as shown in the drawing. This, therefore, made a smooth shelf, 2 feet wide and 3 feet high from the floor. extending around the room, and it was useful for the operations of the department.

Arched openings had been made through the end wall of the existing cellar, to connect it with the new one, and, after the water, steam, and sewer connections had been made, a concrete floor, topped with cement, was laid at the same level as the floor of the old cellar, and joined on to it.

Area-ways about 2 feet deep and 3½ feet wide were then constructed round the outside of the old walls, and a suitable number of windows, glazed with prismatic glass, were opened through them, a stairway to the floor above was constructed, and the new basement was ready for occupancy.

From the day that it was finished we never had the slightest trouble with it.

Ultra-violet Action

M. VICTOR HENRI, assistant in Prof. Dastres Physiological Laboratory at the Sorbonne, and M. René Wurmser have just developed a new theory concerning the action of co-ferments and of anti-ferments; by the action of ultra-violet rays on oxygenated water and on sugars, it is found that poisons paralyze the action of ultra-violet rays in the same way as they paralyze the action of ferments. The action of poisons bears, then, on the substance to be transformed, and not on the ferment as has hitherto been believed.—*Chemical News.*

The Pyrophoric Alloy Industry*

The Modern Substitute for "Flint and Steel"

By Geoffrey Martin, Ph.D., M.Sc.

SOME thirty years ago Auer von Welsbach founded the rare earth industry by utilizing thorium and cerium oxides for the manufacture of incandescent mantles.

Quite recently a new industry has developed out of this older industry, namely, that of the so-called "pyrophoric alloys." These possess the extremely remarkable property of giving rise, when struck by a sharp or hard surface, to such a copious abundance of brilliant sparks, that cigars, cigarettes, gas and other combustible substances may be readily lighted by their aid. These alloys have now been placed on the market as a more or less successful substitute for matches, and the new industry is making rapid headway.

The originator and moving spirit of this new industry was again Auer von Welsbach, and the discovery arose in this manner:—

It is well-known that practically the sole commercial source of the thorium for incandescent mantles is monazite sand, which is a mixture of the phosphates of the rare earth metals, having the following composition:—

	Per Cent.
ThO_2	5—7
Ce_2O_3	25—35
La_2O_3, Pr_2O_3, Nd_2O_3	20—30
Y_2O_3	1—5
P_2O_5	25
SiO_2	1—4

It will be seen, therefore, that in this subtance only a relatively small proportion of thorium is present—5 to 7 per cent—the rest consisting of rare earths of the cerium group. Now the mixture of rare earths which gives the brightest light to an incandescent mantle consists of 99 per cent thoria and 1 per cent ceria, and consequently for the purpose of incandescent mantle manufactures all the thorium is extracted from the monazite sand, but there remains over a great bulk of useless rare earths, amounting perhaps to seventy-five per cent of the whole, and consisting of Ce_2O_3, La_2O_3, Pr_2O_3, Nd_2O_3, etc. In fact, outside the thoria factories little mountains of these waste rare earth oxides have accumulated in the course of years, and as about 3,000 tons of monazite sand is now worked up yearly for thorium, it will be readily understood that the profitable utilization of thousands of tons of these waste earth residues has long been a pressing industrial problem.

Welsbach turned his attention to the matter, and in 1903 made the discovery on which is based this new industry. From the waste cerium residues he prepared the metals by the electrolysis of the fused alkali chlorides, using as negative pole a piece of iron wire. On this he obtained a lump of metal, which he then began to cut away with a knife. He now observed that the outer layers of metal, which consisted of practically pure cerium, cut away without any "sparking" effect, but that as he approached the inner core of iron a vivid display of sparks attended the cutting operation, and that, moreover, the nearer he approached the internal iron core the more pronounced became this effect. On investigating the matter he traced the "sparking" effect to the presence of iron in the cerium metals, the outer non-sparking layers consisting of iron-free practically pure cerium metals, while the internal layers were more and more contaminated with iron the nearer the central iron core was approached.

Perceiving the industrial possibilities of this chance observation, Welsbach at once set to work to prepare a series of alloys of the cerium metals with iron. He found that the greater the percentage of iron in the cerium metal the more pronounced is its property of giving an array of bright sparks when scratched or rubbed, the effect reaching a maximum with alloys containing 30 per cent of iron. Similar effects were exhibited by alloys of nickel or cobalt with the cerium mixed metals—as the mixture of metals obtained by reducing the mixture of rare earth oxides left over after the separation of thorium is called—and in 1903 he took out his famous patent D. R. Patent, No. 154,807, Class 4e (July 31st, 1903).

Welsbach succeeded in selling this patent to the Pyrophoric Metalgesellschaft A. G. of Köln-Braunsfeld for the large sum of 600,000 marks ($150,000) and also disposed of the foreign rights on advantageous terms, the English rights being secured by the British Pyrophoric Metal Company of Leeds.

No sooner, however, had these new companies begun to successfully put these "firestones" on the market when difficulties arose. In Germany, as in other countries a new terror to civilization has arisen in the clever "patent" lawyers, whose business it is to discover flaws in the patents of profitable inventions, and soon the Pyrophoric Metalgesellshaft was involved in the throes of most expensive litigation with rival companies, with the result that the patent was in part upset. Welsbach, however, who was under no obligation to return the purchase-money if this patent was upset, obtained, what few inventors do, the full profits of his invention.

It should be particularly noted that for the manufacture of these alloys pure cerium is never used, but "technical cerium" or "cerium mixed metals," which consist of an alloy of rare earth metals, consisting mainly of cerium, but containing a considerable amount

Fig. 1.—Simple pyrophoric alloy gas-lighter.

of lanthanum, praeseodymium, didymium and neodymium. Although a considerable sparking effect is attainable with alloys containing anything between 10 and 65 per cent of iron, the alloys usually sold for the purpose contain about 35 per cent of iron and 65 per cent of the cerium mixed metals. The cerium mixed metal is usually obtained by the electrolysis of the molten chlorides, but every precaution has to be taken to exclude air, as the metal is extremely oxidizable. Cerium, in fact, is one of the most reactive metals known. It absorbs hydrogen and nitrogen quite readily, while when heated in an atomsphere of carbon dioxide or carbon monoxide it simply decomposes them, extracting their oxygen and depositing carbon. Consequently it is impossible to obtain a gascous atmosphere (if we except the argon group of elements) indifferent to cerium. So reactive is it that it unites with antimony and arsenic with a violent explosion, and the temperature is so high that the bottom of the porcelain crucible melts, allowing the white-hot alloy to pour through in a blazing condition. Cerium, therefore, is a difficult substance to work with, and so only five years ago the cerium alloys were high in price. By means of processes, which naturally are kept secret, the manufacture has been so improved recently that the British Pyrophoric Metal Company of Leeds is now putting the alloys on the market at $8.60 per pound.

The alloys of the cerium mixed metals with iron are usually known as "Auer-metal" sometimes as "cerium-iron," and for hardness or durability in air are among the best of such preparations. However, this "Auer-metal" soon encountered a serious rival in the "Kunheim" metal, which was cheaper and lighter. This latter alloy was patented by the firm Kunheim & Co. (Patent K. 39,885, Class 78f. January 25th, 1909), advantage being taken in this patent of the fact that the cerium metals readily combine with hydrogen to form

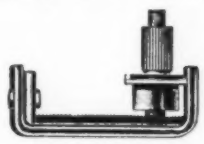


Fig. 2.—Simple pyrophoric gas-lighter (end section)

hydrides. First of all an alloy of the mixed cerium metals is made with magnesium and aluminium, and then this is heated in an electrically heated muffle furnace to a temperature of 500 deg. Cent., while a stream of hydrogen is passed over the surface until no more is absorbed. Finally the alloy is allowed to cool in the stream of hydrogen gas. The quantity of hydrogen taken up corresponds to the complete transformation of the cerium metals into hydrides, 1 gramme of the alloy absorbing 130 to 150 cubic centimeters of *H* gas. By means of this "hydrogenation" process the magnesium-cerium alloy is made very reactive as a sparking agent, and without this treatment the alloy seems to be technically unsuitable for the purpose. It is a curious fact that whereas the pure hydrides of the individual cerium metals rapidly oxidize in the air (and so become useless) and also lose a great part of their hydrogen at a red heat, yet the mixture of metals yield hydrides so stable that they can be heated in air to a red heat without losing much hydrogen. Also the temperature at which the mass is treated with hydrogen is very important since the stability of the alloy in air is largely affected by this.

The composition of one of these "Kunheim" pyrophoric alloys is given as follows:—

	Per Cent.
Cerium	36
Other cerium metals	49
Magnesium	10
Aluminium	1
Iron	0.5
Silicon	0.5
Hydrogen	1.3
Traces of Be, Zr, Ti, etc.	

The cause of the sparking is generally attributed to the fact that the cerium metals are readily oxidizable and, when heated, burn. When a piece of an alloy is struck with a sharp or hard surface, small particles are knocked off, and the heat of friction raises these to their ignition temperature, and they fly off, burning brilliantly. The reason why the pure, individual metals do not show this effect nearly so markedly as the impure alloys is stated by Kellerman to be due to the fact that when the pure metals are used, relatively large particles are detached and the heat of friction is not sufficiently great to set these alight, whereas, when impure alloys are used, smaller particles are knocked off, and the heat of friction heats these more highly than it can larger particles, so that they take fire and burn as they fly through the air.

A few facts about the extent of this new industry may be interesting. In 1911, from 8,000 to 10,000 kilograms of these "pyrophoric alloys" were placed on the market, and as from each kilogram of alloy, from 3,000 to 4,000 "firestones" can be made, the number of "firestones" annually produced goes into tens of millions. One of these small "firestones" will give from 2,000 to 6,000 ignitions—and so is equivalent to from 2,000 to 6,000 matches—before being used up.

Their mode of employment is shown in Figs. 1 and 2, which illustrate a simple gas-lighter, Fig. 1 being a bird's-eye view, and Fig. 2 a section. A piece of the pyrophoric alloy is affixed to the end of an arm movable by pressure like the arms of sugar-tongs. When the arm is pressed, the alloy is rubbed right across a file-like iron or steel surface attached at right angles to the end of the other arm, and the slight friction thus caused makes the pyrophoric alloy give out a brilliant shower of blazing sparks, which then ignites any gas in the neighborhood.

It is also used as a cigarette-lighter. At the top of a small metal box (sometimes shaped like a cigarette, sometimes of larger size) filled with oil and provided with a wick, there is affixed a small piece of pyrophoric alloy, and above this is a steel cog wheel, which can be pressed against the alloy. When the cog wheel is rotated by pressure of a finger, the rotating cogs strike against the pyrophoric alloy just below and detach a shower of brilliant sparks, which then lights the wick. In some forms, the piece of pyrophoric alloy is placed on a box, whose lid is actuated by a powerful spring. When a knob is pressed, the lid flies open and the spring simultaneously sets into rapid motion a steel cog wheel with a rough edge, which, while rotating, strikes off a shower of sparks from the alloy and so automatically lights a wick.

In France, especially, where the match industry is a monopoly in the hands of the Government, and consequently, matches are dear, this new industry has made very considerable headway.

As regards its future development and the ultimate replacement of the ordinary match by such alloys, only a very bold man would care to make a definite prophesy. The invention, in fact, is a highly efficient revival of the old "flint and tinder" method of obtaining fire, which was in use before the advent of the match, and now this long-dead industry appears without warning, to have suddenly flickered up into life again.

German foresters are experimenting with Douglas fir from the United States trying to find a variety which will combine the fast-growing quality of the Pacific Coast form and the hardiness of the Rocky Mountain form.

* Reproduced from the *Chemical World*.

Heavy Oil as Fuel for Internal Combustion Engines*

Encouraging Results Obtained with Diesel Motors

By Irving C. Allen

On the Pacific and Gulf coasts of the United States there is produced a great quantity of heavy asphaltum oils. These may be refined and first-class products manufactured therefrom. In this refining, as also in the refining of the petroleums from the other oil fields of the United States, there is produced a so-called gas oil, which is that portion of the petroleum distilling between the heavy naphthas or kerosenes and the light spindle oils. This gas oil may be burned with good results as a fuel under steam boilers.

By being mixed or blended with a small proportion of the low-boiling natural gasolines, gas oil can be enlivened, by increasing its volatility and lowering its specific gravity and flash point, and made to burn in explosion engines. Even with the above uses gas oil has been produced in greater quantities than can be efficiently consumed, and its profitable disposal has been a burden on the refiners.

This led to a search for more efficient means for its use. The heavy-oil internal-combustion engine—that is, the various modifications of the Diesel type—seemed to open a promising field, and a critical study of these engines abroad and in the United States has developed encouraging results. A study of the use of gas oil in this engine has naturally led to the study of similar oils, and it developed that there are being produced in greater and greater quantities in the United States coal tars and tar oils from gas works and coke plants. These tar oils burn successfully in the heavy-oil engine, and are therefore an additional and important source of power.

The alcohols burn successfully in heavy-oil engines when mixed in the proportion of 80 parts of alcohol with 20 parts of benzene. The wood alcohols, by-products of destructive distillation of waste woods, and also alcohols prepared as products of fermentation from grains and other carbonaceous materials, as waste cornstalks, grain stalks, etc., offer a most promising field as a source of fuel for these engines whenever such products from these waste materials are produced in greater quantities than can be economically used in other ways, and when in an emergency a demand for liquid fuel becomes imperative.

OUTLOOK FOR SUITABLE FUEL.

These great sources of liquid fuels open practically an unlimited supply for heavy-oil engines, and the future for these engines in this country is very promising. It would be to our material advantage to manufacture from our bituminous coals, woods, and oil residues the gases, tars, cokes, and the many other by-products, and to use these in their proper places in the industries rather than to burn the crude materials wastefully, as at present, directly under steam boilers for power generation. This would not make oil a competitor to the disadvantage of coal, but would increase the usefulness of coal by developing its possible by-products and thereby increase the value of the raw coal itself.

As approximately 0.4 pound of an oil similar to gas oil will produce 1 horse-power-hour when burned in a heavy-oil engine, the total production of gas oil from the petroleum fields for 1911 would alone, without considering the vast resources of coal and wood oils, develop approximately 6,351,213,645 horse-power-hours without in any way interfering with the uses of the other petroleum products now manufactured. This would mean the addition of about 725,000 horse-power running continuously throughout the year.

THE HEAVY-OIL ENGINE.

The foregoing grouping of oils is intended to include those suitable for fuel in the various forms of engines developed from the Diesel engine. The particular features of this type of engine are briefly described for this paper by O. P. Hood, chief mechanical engineer of the Bureau of Mines, as follows:

Oil engines have been built, using the heat of combustion in several ways to develop power. The ordinary explosion type of engine, in which the combustion is completed in so short a time that practically no change in the cylinder volume takes place during combustion, employs a method of using heat much more efficient than the method available for a steam engine, yet far less efficient than is actually possible. In an attempt to realize in an engine the most favorable method of using heat, Dr. Rudolph Diesel, of Munich, proposed in 1893 what has proved to be, from a thermal standpoint, the most economical heat engine so far devised, and the one that most nearly approaches theoretical maximum efficiency. This engine is especially adapted to the burning of heavy oils. Its operation has two features that distinguish it especially from the explosion type of engine, which it most nearly resembles.

First. The combustion is not instantaneous, but takes place during an appreciable change in cylinder volume. All of the combustible material is not in the cylinder at the moment of ignition, as in the explosion engine, but is fed in and burned while the piston is moving. The heat is thereby generated at a more nearly constant temperature and does not reach the high temperatures or pressures of the explosion engine, which are generated practically instantaneously.

Second. Another peculiar feature of the manner in which this engine utilizes heat is the compression of the air for the combustion to such a degree that the heat developed thereby approximates the temperature obtained by the subsequent burning of the fuel.

This high elevation of temperature by compression is a necessary part of the improved method of using heat. It also causes the spontaneous ignition of the charge of fuel, although that is not the chief reason for the high compression. Such high compression is impossible in the explosion engine because the air, which also contains the full charge of combustible, would reach the ignition temperature too soon, and would produce a premature explosion. In the Diesel type of engines, however, the fuel is not introduced until the compression and heating of the air is completed. The high temperature of the compressed air, which is well above the ignition temperature of most fuels, makes it possible to dispense with any other ignition system, so that the engine in this respect in much simpler than the explosion engine. The necessity, however, of introducing the fuel into air that is under high pressure makes the introduction of fuel more difficult than in the explosion engine.

The cycle of operation of the Diesel engine, therefore, is to compress air to 450 to 500 pounds pressure per square inch, thereby generating a temperature of approximately 540 deg. Cent. Into this highly heated air the fuel is injected during the return or second stroke of the engine, in a finely atomized form, at such a rate as will maintain an approximately constant temperature while burning and in such quantity as will yield the required work for that stroke. During the third stroke of the piston the expanded gases of combustion are pushed out of the cylinder, while a fourth stroke draws fresh air into the cylinder in preparation for a repetition of the cycle. This is the sequence of events in a four-cycle engine.

By supplying other means of freeing the cylinder from burned gases and refilling it with fresh air the necessary functions can be performed in two strokes of the piston, producing the so-called two-cycle engine.

In general appearance these engines are like explosion engines, although not built so heavily. They are provided with similar jacketing systems, cam-operated poppet valves, and heavy flywheels. They are usually built as single-acting vertical trunk engines, but are also made of the crosshead type, horizontal and double-acting.

In the four-cycle engine but one impulse is given to the piston in each two revolutions of the flywheel. In order to produce uniform angular velocity without excessively heavy flywheels, multiple cylinders are employed. There is also a practical limit to the size of any one cylinder, so that for large powers multiple cylinders are used at present almost to the exclusion of large single-cylinder engines, although further tests are being made of the practicability of the latter.

The Diesel engine has become a type of prime mover. It is based on certain principles, but is differentiated into many forms by different designers who seek various mechanical devices for reducing troubles and for more perfectly realizing the theoretical heat cycle developed by Diesel.

Among the mechanical difficulties giving rise to the great number of variations in design are those of introducing the fuel, scavenging the cylinder, and starting and reversing the engine.

The fuel is injected, atomized or sprayed into the clearance space of the cylinder by air under a pressure sufficiently above that of the air compressed in this space. The air for injecting the fuel has to be under a pressure of about 700 or 800 pounds per square inch, and its reliable compression and storage form one of the mechanical difficulties of the engine.

In an attempt to avoid such high compression pressures and the resulting complications of design necessary in a true Diesel engine, the so-called "semi-Diesel" engine has been devised which does not compress the air charge sufficiently to raise its temperature to such a point that it will spontaneously ignite the injected fuel. Such engines depend upon projecting metallic parts within the head of the cylinder or upon external chambers communicating therewith that retain sufficient heat from the combustion of the previous charge to vaporize and ignite the fuel as injected. It is necessary to first heat such devices by some external source of heat in order to start the engine, but once the engine is running, the hot chamber insures spontaneous ignition. The fuel is introduced through similar fuel valves but requires less compression of air than is required in the true Diesel engine. Although such engines have theoretically a less efficient heat cycle than the true Diesel, they gain in simplicity of mechanism.

The scavenging of the cylinder performed by one stroke of the piston in the regular four-cycle engine is accomplished in some designs by blowing low-pressure air through the cylinder at the end of the exhaust stroke, this air being compressed either in the closed crank case or in an added cylinder.

To start Diesel engines, compressed air is stored in containers and let into the engine cylinders through separate starting valves.

USE OF THE HEAVY-OIL ENGINE IN THE UNITED STATES.

Diesel developed his engine in the early nineties, and has since then greatly improved it and has made of it a most successful and efficient power producer. At present it is thoroughly dependable and will burn a great variety of oils. Although the engines are reliable, lack of experience in handling engines with such high cylinder pressures has raised in some cases an undeserved prejudice against their use. Trouble in starting is usually due to unclean and ill-adjusted valves, and an auxiliary air supply is necessary. The exhaust valves become pitted and must be reground about every three months; but 15 minutes should suffice to replace a worn valve with a new one. Also, more lubricating oil is required than with a steam engine.

REQUIREMENTS OF A HEAVY-OIL ENGINE.

The features that are desirable in a heavy-oil engine may be briefly set forth as follows:

1. The engine should primarily be constructed for burning heavy oils and residues, and particularly those oils containing asphaltums, such as the petroleums of the Pacific and Gulf coasts, because these oils are produced in large quantities and are the fuels now available in commercial quantities.
2. The engine should start without delay or trouble.
3. It should show reliability and general good-running qualities.
4. It should run equally well at full load and at no load, and with variable loads where speed variations are required.
5. It should run steadily enough to drive a dynamo for electric lighting.
6. It should burn the fuel completely and not give an unpleasant odor or smoke from the exhaust.
7. Its first cost should be low.
8. It should be simply constructed and should not require a machinist of superior ability to care for it.

FUEL ECONOMY OF HEAVY-OIL ENGINE.

The fuel economy of the heavy-oil engine may be briefly summarized as follows:

In a heavy-oil engine 200 to 250 grams (approximately 0.4 pound) of oil are consumed in developing 1 horse-power-hour, whereas for a steam engine of the best triple-expansion type, from 1.1 to 1.8 pound are necessary. This difference in fuel consumption gives an efficiency of the oil engine compared with the steam engine of from 0.4 to 1.1 pound, or a ratio of approximately 1 to 3, or, conservatively, 10 to 25 in favor of the oil engine. The efficiency of coal as compared with fuel oil for steaming is variously estimated at 10 to 17, 10 to 15.5, and 10 to 16.1.

It may be of interest to note that a turbine engine taking steam from boilers fitted with the best Koerting burners for oil, with accessories complete, built by the Franco Tosi Co., Milan, and installed at the Turin Exposition in 1911, required at least two and one half times the weight of oil fuel per horse-power that did a Diesel engine built and installed by the same company at the same time and place for purposes of direct comparison, thus giving a ratio of 25 to 10 in favor of the Diesel engine.

The quantity of oil required in a heavy-oil engine and its resulting efficiency, estimated within a margin of about 5 per cent, is approximately shown in the table following:

*Reproduced from *Industrial Engineering and Engineering Digest.*

FUEL CONSUMPTION AND EFFICIENCY OF A HEAVY-OIL ENGINE.

Load.	Oil per brake horse-power-hour, lb.	Thermal efficiency (based on brake horse-power-hour), %	Mechanical efficiency, %
Full load	0.472	30	74
⅞ load	.500	....	65
½ load	.562	26	58
¼ load	.748	....	47

The distribution of the total heating units from an oil when used in a Diesel engine is about as follows:

HEAT BALANCE OF THE DIESEL ENGINE.

	Per cent.
Total heating value of fuel	100.0
Brake horsepower (Ind. H.P. = 44.2)	32.7
Friction of air, water, and oil pumps	11.3
Cooling water	33.3
Exhaust gases	22.7

The heavy-oil engine is being installed in a great variety of plants to produce power for many different uses. The stationary engines in use vary in size from 50 horse-power to large central-power installations, and they seem to run with perfect satisfaction.

FUELS THAT CAN BE USED IN THE HEAVY-OIL ENGINE.

Many liquid fuels can be burned successfully in heavy-oil engines. Petroleum products of all kinds from whatever source, from the lightest lamp oils to semifluid residues, have from time to time been successfully used. In short, the following oils and mixtures of them have been used successfully in heavy-oil engines, provided they were mobile, free from free carbon, grit, and water, and were low in sulphur:

Petroleum Products: Gasoline; lamp oils of all kinds; naphthas; gas oils; fuel-oil distillates; "masut" or residues from the crude oils of Russia; and crudes, if mobile.

"Steinkohle" Oil Products: Heavy oils, anthracene oils; and tar oils.

Bituminous Oils: Retort oils of all kinds.

Lignite Products: Benzene; solar oils; paraffin distillates; and creosote oils.

Turf Oils: Creosote oils.

Shale Oils.

Vegetable Oils: Peanut oil; cocoanut oil; castor-bean oil; cottonseed oil; and palm-seed oil.

Animal Oil.

Alcohols.

Wood Oils: Creosotes.

TREATMENT OF HEAVY OILS TO MAKE THEM MOST SUITABLE FOR FUEL.

Any fuel that will flow freely can be burned in a heavy-oil engine. Though this in a measure is true, heavy tarry oils, if not kept perfectly fluid by heating, will cool and tend to clog the pipes and valves. It is advisable, therefore, to first subject the tarry oils to a distillation, distilling over everything up to the tar residues or even to the cokes, and to use this distillate for fuel without further treatment. The cost of distillation will be outweighed by the more satisfactory running of the engine.

When the fuel oil is heavy and contains little volatile material, it is advisable to inject alongside the main fuel spray, by means of an auxiliary spray, a small quantity of an oil having a relatively low flash point, such as a heavy benzene or a "gas oil." This ignition oil, igniting at the proper moment, will in turn ignite the more sluggish fuel oil, and proper ignition will thereby be insured. The ignition oil may also be injected within the fuel valve or first blended with the fuel itself in the storage tank.

Satisfactory ignition has resulted from injecting the following quantities of an oil of low flash point into the immediate neighborhood of the fuel-oil spray:

PERCENTAGE OF IGNITION OIL COMPARED TO WEIGHT OF FUEL

	Per cent
At full load	1.5
At three-fourths load	6.9
At one-half load	12.7

SPECIFICATIONS FOR FUELS AND LUBRICANTS FOR HEAVY-OIL ENGINES.

The consensus of opinion seems to be that an oil to burn with success in heavy oil-engines should possess the following characteristics:

Solidifying Point.—The oil should be mobile at 0 deg. Cent. If it be heavy or viscous or contain a considerable proportion of asphaltum of paraffin, it will become sluggish and stiff at low temperatures, and considerable heat will have to be used to warm it before it can be run into the engine.

Fluidity.—Sluggish oils should first be heated before being introduced into the engine. If it be necessary to use very heavy oils, the engine should first be warmed by running on a more fluid fuel and the heavy oil introduced only after the engine is hot and running well. This process should be reversed when shutting down, and the heavy oils should be washed out of the engine valves and pipes with a lighter oil, the engine being run a short time on one of these lighter oils before it is allowed to become cold.

Tar Content.—An oil should contain not more than 0.4 per cent of material insoluble in xylene, as a larger proportion of insoluble material will tend to form coke in the cylinders. (Ten grams of the sample mixed with 10 cubic centimeters of xylene shaken and filtered should show not more than 0.04 gram increase on the filter.)

Coke Residue.—The residue on coking should be not greater than 3 per cent. A high content of asphaltum or free-carbon will give considerable trouble by coking in the cylinders.

Free-carbon Content.—There should be not more than a trace of free carbon in the oil, as free carbon tends to clog the valves and to deposit on the surfaces of the cylinders.

Volatility.—At least 80 per cent of the oil should distill over at 350 deg. Cent., for oil leaving more than 20 per cent residue at this temperature will show a large carbon content by coking.

Distillation.—Heavy oils and residues, though they may be successfully burned in a heavy-oil engine, should properly be distilled (not refined) before using, as it is cheaper to prepare the oil before introducing into the engine than it is to dismantle the engine, or a part of it, for cleaning.

Flash Point.—The flash point should be between 60 and 100 deg. Cent. A small proportion of oil of a low flash point is required to insure ingnition.

Ignition Oil.—In general a heavy oil containing no material having a low flash point should be enlivened by the addition of about 2 per cent of a "gas oil," flash point 60 to 100 deg. Cent. or less, before being fed into the cylinders.

Specific Gravity.—The specific gravity in itself, although of little significance, should be not greater than 0.920, because when greater the large proportion of heavy residual material would give trouble in the engine. In general the boiling point or distilling proportion is of more importance.

Calorific Value.—The heating value should be not less than 9,000 calories, and the hydrogen content not less than 10 per cent, as lower values are approaching the value of pure carbon and will give poor combustion.

Sulphur Content.—The sulphur content should be not more than 0.75 per cent, as a greater proportion may attack the cylinder walls and will tend to pit them, making them rough. Brass, zinc, and copper are to be avoided in the surfaces exposed to combustion. Nickel steel seems to be the most resistant material.

Acid and Alkaline Content.—The oil should contain no free ammonia, alkalies, or mineral acids, because of their pitting effect on the surfaces exposed to combustion.

Ash Content.—The oil should contain not more than 0.05 per cent of noncombustible mineral matter, because such matter tends to hasten carbonization within the cylinders and to prevent proper combustion.

Water Content.—The water content should be not greater than 1 per cent. One per cent of water reduces the calorific value by 1 per cent. Moreover, to raise the temperature of 1 gram of water from room temperature, say 30 deg. to 100 deg. Cent. requires 70 calories, and to evaporate 1 gram of water at 100 deg. Cent. into steam at 100 deg. Cent. requires 536 calories. Hence 1 gram of water causes a total reduction of 536+70, or 606 calories, and to raise the temperature of the steam to that of the cylinder requires still more heat. The absorption of heat in raising the temperature of the steam is partly compensated by the action of the steam in expanding and performing work on the piston, there being an abundance of heat in the cylinders. In short, 1 per cent of water in the fuel itself will cause a loss of approximately 1.06 per cent in the calorific value of the fuel. It must also be remembered that a drop of water suddenly generated into steam within the fuel spray at the instant of ignition may lower its temperature and thereby prevent ignition, and a number of such drops in succession might stop the engine.

Resin Content.—The resin content should be low, as resins have a tendency to carbonize readily and will tend to coke in the cylinders.

Creosote Content.—Oils containing creosotes up to 12 per cent, though causing smoke to some extent, can be burned; a higher percentage of creosotes gives trouble by coking.

Paraffin Content.—A paraffin content of 15 per cent will give some trouble. An oil containing a still higher percentage of paraffin, because of the large quantity of oxygen necessary for complete combustion, will burn with more difficulty.

Asphaltum Content.—The heavy-oil engine, at least so far as the use of asphaltum oils is concerned, is still in its experimental stage, but the assumption can fairly be made that when the mechanical difficulties are surmounted it will be practicable to burn any fuel oil containing asphaltum that is sufficiently fluid to flow, providing the oil be free from solid matter and water. An oil containing 21 per cent asphaltum has been successfully burned.

Atomization.—Fine atomization is essential, for if the fuel enters the cylinder in drops of appreciable size, which can burn only from their surfaces, it will not have time for complete combustion. The fuel will consequently strike the sides of the cylinders and the piston head and there carbonize.

LUBRICANTS.

It is of importance to examine carefully the lubricating oils for use in cylinders and pumps.

Viscosity.—The viscosity should be between 9 deg. and 10 deg. Engler at 50 deg. Cent. A lubricant of a much less viscosity would tend to burn and one of greater viscosity would tend to carbonize and would not lubricate so well.

Solidifying Point.—The lubricant should be liquid at —5 deg. Cent. and should not freeze solid above—10 deg. Cent.

Flash Point.—The flash point should be between 220 deg. to 240 deg. Cent., Pensky-Martens closed tester.

Carbonization.—When agitated with concentrated sulphuric acid the lubricant should lose not more than 10 per cent by carbonization. This sulphuric-acid test gives an indication of the quantity of unsaturated hydrocarbons present.

Solubility.—The lubricant should dissolve completely and clearly in benzene.

Acidity.—The lubricant should be free from acids and alkalies, as these pit the metal surfaces, and free from resins and fats, as these saponify readily.

Animal and Vegetable Oils.—Because of their tendency to decompose, animal and vegetable oils should not be used.

CONCLUSION.

The heavy-oil engine can not yet be considered as fully developed, and much work remains to be done in perfecting it. With the present imperfect knowledge of what the engine is capable of doing and of what particular oils can be successfully used in it, one can not speak conclusively as to definite specifications for fuels and for lubricants, and those outlined above must be considered, therefore, as tentative.

But the fact that petroleums containing as high as 20 per cent asphaltum as well as oils from tars have been successfully used is most encouraging. The future of the engine, and also a more efficient utilization for asphaltum liquid fuels and coal and wood by-product liquid fuels is assured.

Plants Cultivated at the Neolithic Epoch

IT is generally admitted that the men of the age of hewn stone were exclusively hunters. With the invassions, probably of Asiatic origin, which brought into Europe a part of the Neolithics (dolichocephalic races) the manner of living changes; from pastoral it becomes sedentary. The Neolithics begin to raise domestic animals and to cultivate certain species of plants, the remains of which are to be found in the lake dwellings. Prof. Schenk has brought this question to an interesting point. Corn is the most ancient, or one of the most ancient, plants known. Prette and Boule have observed samples of it in the celebrated layer of the Mas d'Azil (Tourassian period or end of the hewn stone period). Corn is to be found in all the lake dwellings. It is identical to the Mottu corn still grown to-day (for straw for plaiting) in the Gruyère Valley, Canton of Fribourg. Zaborowski believes that this kind of plant is essentially of Asiatic origin. It would then have been brought into Europe by the dolicocephalic neolithic invaders. Egyptian wheat has also been found in several lake dwellings. Barley is also pretty frequent; it is represented by six very distinct varieties. On the other hand, rye and oats were known but were very rare. Flax was represented by a different kind from the present species, and which is still living to-day in a wild state in the Mediterranean basin. The other plants of the lake dwellings were probably gathered in a wild state. It was especially fruits which were generally cut in quarters and dried, such as certain little species of apples and pears; among these latter the present Swiss species of *Achras* has been found. Most of the wild fruit was consumed more or less accidentally. As to the origin of these neolithic species it does not seem that this question has progressed much since Heer and Candolle.—*Chemical News.*

Intense Cold Can Be Easily Obtained

THE well known engineer, M. George Claude, has just indicated a means of obtaining the very low temperatures (so much sought after at present) by the help of liquid nitrogen that can be very easily procured in the manufactories that produce liquid air. The fact is, that by bubbling a current of hydrogen in liquid nitrogen, it is easy to obtain in vessels open to the free air the temperature of —211 degrees, which corresponds to the solidification of the nitrogen, and thus presents the advantage of constituting a veritable fixed point.—*Chemical News.*

Room 3 Room 2 Room 1

Fig. 1.—Showing importance of shading lamp.

Room 3 Room 2 Room 1

Fig. 2.—Variety of light distributions obtained by use of ordinary reflectors.

Some Phases of the Illumination of Interiors*

A Demonstration of Lighting Effects

By Preston S. Millar

It is the purpose of this presentation to indicate in a non-technical manner some of the features of the illumination of interiors which have been studied, and upon which we have some information as a basis for practice.

If a room be illuminated by a bare lamp (Fig. 1, right), the results are unsatisfactory for a number of reasons. In the first place, the walls receive the major amount of the light produced and the portions of the room in which the light is more likely to be utilized, are inadequately illuminated. The light source is unattractive, and, when within the field of vision, is annoying, if not actually injurious to the eyesight. This latter effect, included under the name of glare, is very noticeable in the illustration, where the lamp is at the center of the field of vision, and the effect is exaggerated beyond that which would be experienced by occupants of the room.

If the lamp be shielded from view (Fig. 1, left), conditions are much improved. Much of the discomfort and annoyance disappears. While the distribution of light on surfaces seen within the room is not changed materially, yet everything can be seen more distinctly. Observe, for example, the vertical stripes upon the wall-paper. Beginning near the floor, trace a vertical stripe which is at some height, almost, if not quite, in line with the lamp in room No. 1 (to the right). It will be noticed that as the gaze approaches the vicinity of the lamp, it is difficult to see the stripe, and that when level with the lamp, the stripe disappears entirely. In room No. 3 (to the left) in which the lamp is shielded from the eye, the corresponding stripe may be distinguished when looking just past the lamp and screen.

One of the important functions of a reflector or other lighting auxiliary is to thus shield the lamp from view, by interposing between it and the eye, either an opaque or a translucent medium. This is accomplished in room No. 2 (Fig. 1, middle).

But a reflector should fulfill other, equally useful, purposes. In shielding the lamp from view, it may also be made to direct a considerable proportion of the light where it can be utilized to best advantage. Much study has been given to this aspect of the problem, and the performance of any standard type of reflector may be ascertained by reference to photometric tests of light distributed downward or may be judged from the floor brightness.

In no branch of illumination have such great strides been made in the past ten years as in the design of reflectors in particular, and lighting auxiliaries in general.

It has been noted that the bare lamp distributes but a small proportion of the light downward. In room No. 2 (Fig. 2) a reflector is employed which redirects downward a goodly proportion of the light, illuminating the card below it much more brightly than would a bare lamp. In room No. 3, this re-direction of light is effected in such a way as to concentrate a large proportion directly below the lamp, thereby illuminating the card to a brightness which is about twice that of the card in room No. 2, which was considerably brighter than the card in the room where no reflector was used.

Light Medium Dense

Fig. 3.—Showing improved appearance when glassware is dense enough to conceal lamp.

In room No. 1, as now equipped, a reflector is employed which has been designed without regard to optical laws, and which, though looking like a prismatic reflector, has in fact almost none of the qualities which characterize such glassware. It accomplishes little in the way of re-direction of light, while affording but an ineffectual protection for the eyes against brightness of the filament. It absorbs a certain amount of light without rendering any adequate return in improvement of conditions.

Viewed from direction in which glare is not apparent. Viewed from direction in which glare is apparent

Fig. 4.—Showing glare due to specular reflection from glossy surface

In the three rooms there is illustrated the range of practicable accomplishment in the employment of reflectors, if we omit opaque reflectors, which would not be suitable for employment under such conditions. In room No. 1, general distribution of the light throughout the room; in room No. 2, effective re-direction of much of the light downward, largely increasing the intensity on the table plane, though illuminating the walls and ceiling brightly enough to avoid the appearance of dimness. In room No. 3, the concentration within a small area beneath the lamp is very marked, this being effected by taking from the walls and from the table plane near the walls, a portion of the light which falls upon them in room No. 2, and concentrating it upon, or near, the table. The relative intensities of light distributed downward may be judged from the floor brightness.

The correct design of a reflector to accomplish a given purpose, involves the application of well-known optical laws. With prismatic glass and mirror types of reflectors, a wide variety of distribution may be obtained. With opal or phosphate glasses, such as that in room No. 2, the possibilities of securing high concentration are rather more limited, though with this one exception these too may be designed to produce practically any distribution likely to be required.

In achieving the particular distribution which characterizes a given reflector, it is important that the light source be correctly located with reference to the reflector. The use of an incorrect shade holder, or of an improper lamp distorts the distribution and usually detracts from the appearance and usefulness of the lighting unit.

In reflectors, as well as in globes and other forms of glass lighting auxiliaries, the degree of optical density is important, affecting both the performance and the appearance of the glass. This is an important feature to be considered in selecting glassware. In the now rather common forms of display street lighting, which utilize clusters of tungsten lamps in globes, very displeasing effects are sometimes encountered, due, first, to the non-uniformity of the globes, and second, to the insufficient density which makes the location of the lamp apparent, instead of rendering the whole surface of the globe equally bright, making it appear a ball of light. Much of the lighting glassware in use in residences a few years ago, and it is to be feared even to-day, consists of etched or frosted crystal glass which serves chiefly to give the fixture a somewhat finished appearance. It neither directs sufficient light usefully to make it efficient, nor conceals the light source sufficiently to make it attractive or of value in protecting the eyes.

In Fig. 3 there is a globe of crystal glass, roughed inside, a light opal globe, and a denser opal globe. The last presents a better appearance without involving serious sacrifices otherwise. The light absorptions of these balls are respectively:

Frosted ball	6 per cent
Light opal ball	13 per cent
Dense opal ball	22 per cent

When employed in the miniature rooms shown in Fig. 2, the relative light intensities throughout the table plane averaged:

Frosted ball	100 per cent
Light opal ball	106 per cent
Dense opal ball	95 per cent

* A paper and demonstration given before the following sections of the Illuminating Engineering Society; New York, November 18th, 1912; Philadelphia, February 21st, 1913; New England, March 12th, 1913: and published in the *Translations of the Society*.

Room 3 Room 2 Room 1

Fig. 5.—Appearance with various wall decorations. The influence of these upon the amount of light is very marked.

Room 3 Room 2 Room 1

Fig. 6.—Appearance with various wall decorations. The walls are made bright enough to produce a cheerful appearance.

Room 3 Room 2 Room 1

Fig. 7.—Indirect lighting.

Room 3 Room 2 Room 1

Fig. 8.—Semi-indirect lighting.

In passing I wish to refer to the great diversity of lighting fixtures and glassware which are now available in standard types, awaiting selection. Practically all ordinary requirements in interior illumination may be filled by lighting auxiliaries selected from those now upon the market. In regard to efficiency, most of the reflectors and globes which pretend to be efficient accomplish their purpose admirably. In fact, so carefully has this element of the question been studied, that an inefficient reflector cannot to-day be successful unless it has some compensating advantage, which renders it superior for some purposes in spite of its inefficiency. I recently went through the interesting experience of making a comparison of the standard types of reflectors which were upon the market ten years ago, and comparing them with types now available. In regard to efficiency, the improvement has been very marked. Absorptions of 10 to 20 per cent now rule, where ten years ago absorptions of 25 to 40 per cent were typical for reflectors of substantially similar light distribution characteristics. Improvement in the quality of reflecting surfaces has gone hand in hand with improvement in the design of the curvature of such surfaces. As in efficiency, so it is in appearance. Most of the reflectors of ten years ago were opaque, and few were pleasing to the eye. To-day even in the reflectors where efficiency in light re-direction is the chief aim, pleasing appearance is the accepted order.

In the class of lighting auxiliaries in which decorative effect is the chief object, a wide variety is available, and much of it is pleasing and tasteful. Unfortunately, however, such auxiliaries are characterized by inefficiency to an extent which appears rather unnecessary. It is probable that in the developments of the next few years, we shall note a strong tendency to improve the efficiency of some types of decorative reflectors, without interfering with their decorative qualities.

The influence of room decoration upon the amount of light required to illuminate a room properly is very marked; or, stated otherwise, with a given amount of light produced in a room, the effectiveness of the illumination is largely influenced by the character of the decorations. Considering the simple case of a bare lamp, employed to illuminate rooms having light, medium and dark walls respectively, we may note a number of interesting effects (Fig. 5). In the first place, the illuminated card on the table in room No. 3 appears brighter than the cards in the other rooms. It must be apparent that the card cannot be brighter because it receives light from the lamp and the ceiling only, while the card in room No. 1, for example, receives light from the corresponding light sources and ceiling which is enhanced considerably by light reflected from the walls. The card in room No. 1 is actually 30 per cent brighter than the card in room No. 3. That it does not so appear is an example of the effect of contrast, which in illumination is a very important fundamental. A corresponding comparison may be made by observing the upper part of the wall in each room, where again the white paper appears brighter in room No. 3 than in the other rooms. Though actually not so bright as the white surfaces in rooms Nos. 1 and 2, these surfaces appear brighter in room No. 3 in comparison with the dark wall-paper to which the eye naturally adapts itself more or less.

In room No. 1, portions of the furniture which are but slightly illuminated, as legs of the table, stand out distinctly, being silhouetted against the light rear wall. In room No. 3, so small is the contrast between the rear wall and the dimly lighted portions of the furniture, that it is difficult to discern the latter.

The glare due to the exposed light source is more serious in room No. 3, due to the larger contrast between the light source and the walls. Shadows of the furniture against the walls are very prominent by contrast in room No. 1, in spite of the fact that the shaded areas are more brightly illuminated by light which is generally diffused within the room.

In considering this photograph, it should be remembered that no light-directing auxiliary has been employed, and that therefore a larger proportion of the light falls upon the walls than good practice would dictate, if we except the darker room. In most installations it is desirable primarily to secure the proper illumination of the lower part of the room, where the light is utilized, the other requirements being that the ceiling and walls shall be illuminated sufficiently to make the effect pleasing. When reflectors are used, the lighting effect of ceiling and wall decorations is reduced greatly, if the reflectors are concentrating in character, and reduced slightly, if they distribute the light rather broadly, about the lower part of the room.

The brightness of walls is an important element, affecting ocular comfort probably more seriously than the illumination of the table plane. Generalizing, it is probably the best rule to avoid extremes of wall decoration, whether they be light or dark. If the walls are of high reflecting power, it is important to so direct most of the lighting that the amount permitted to fall upon the walls will not render them so excessively bright as to be trying to the eyes. The illuminating engineer cannot control wall decorations, but he can control the light produced within the room, and can so direct it as to secure the best effects.

In the next photograph, Fig. 6, a reflector which directs the light downward rather largely is shown.

This detracts from the brightness of the upper portions of the walls, the change of course being most apparent in room No. 1, where, due to the relatively high reflecting power of the wall-paper the wall was brightest in the last photograph. The lower portions of the walls are somewhat brighter than when bare lamps were employed. Due to the better lighting of the floor, the lower portions of the table and chairs, which with the bare lamps could hardly be seen, are now slightly illuminated. With this installation the effect of the ceiling and walls is lessened, because a smaller amount of light is permitted to fall upon them reducing their illuminating power. That is to say, when a suitable reflector is employed, the table plane illumination intensity is more nearly independent of reflection from ceiling and walls, and instead of relying upon the latter for assistance in producing useful illumination, the problem is simplified to one of rendering the walls bright enough to produce a cheerful appearance.

It has been shown in the above that the ceiling and wall decorations, when light in tone, may be of material assistance in increasing the illumination intensity on the table plane. It may be argued as the corollary of this, that when the walls are dark and incapable of augmenting the table plane illumination materially, the use of reflectors for that purpose is all the more important.

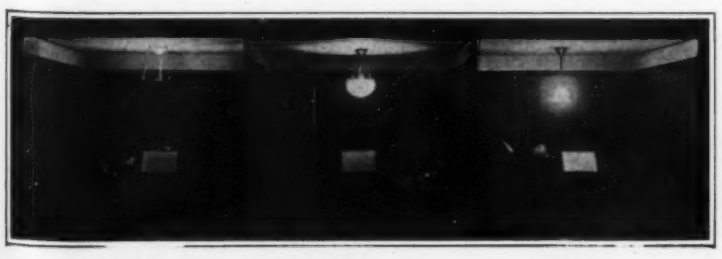
I have discussed the effect of glare due to the presence of a bright light source within the field of vision. This effect would be almost, if not quite as disturbing, if instead of having a lamp within view, an image of the lamp were to be seen in a mirror. In that event, the effect would be due, not to the presence of the light source, but to specular reflection of the light from the mirrored surface. It is perhaps unfortunate that most artificial surfaces which we are likely to view are sufficiently glossy or polished to partake in some measure of the qualities of a mirror; that is, to reflect light specularly. Some surfaces which are very mat and free from gloss, diffuse the light so generally that the

Good reading posture Very undesirable reading posture Undesirable reading posture

Fig. 9.—Showing manner in which a table lamp may be used.

Difficult to light Best adapted to the eye

Fig. 10.—Illumination from wall brackets alone. **Fig. 11.—Daylight illumination.**



Indirect Semi-indirect Direct

Fig. 12.—Three common methods of illumination

Room 3 Room 2 Room 1

Fig. 13.—Suggesting decorative or ornamental lighting units

specular element of the reflection is immaterial for most purposes. But in most paper employed in books and magazines, there is a considerable element of specular reflection, and this characteristic is responsible for much of the difficulty which demands adroit handling by the illuminating engineer in utilitarian lighting.

Referring to the demonstration cards (Fig. 4), it will be noted that the paper and letter on the right half of each have glossy surfaces, while those on the left have diffusing surfaces being almost totally free from specular reflection. On the right half, one may see, when in line with the direction of the reflection, a distorted image, or a number of distorted images, of the light source, much as though he were viewing the source through a very imperfect mirror. On the left it is noted only that the surface is illuminated and no trace of an image of the light source may be seen. From all positions the letter on the left half of the card may be seen. From a particular direction (right photograph), that upon the right half of the card can be seen only with great difficulty, if at all, because it is viewed from the direction in which the glare is manifested.

The oil lamp has in recent past years been the standard of comparison for artificial illumination. Even to-day it is traditional among oculists that there is no artificial illuminant which yields a light so free from detriment to the eyesight as does the oil lamp. It is, therefore, of interest to note some of the conditions under which the oil lamp has been used. Being essentially a small illuminant, and both self-contained and portable, it was natural that it should be placed close to the object viewed. This entailed locating it more or less on a level with the eyes, and so near to the observer that shielding the former became a matter of natural course. In that fact is to be found the reason for the development of the oil lamp shade. Given a small illuminant, shaded for the protection of the eyes, there was no condition under which visual difficulties could be experienced unless it were attempted to read with the book in the illuminated zone near the lamp base, with the reader facing the lamp (Fig. 9). Under such conditions, glare due to specular reflection from the paper might be detrimental to vision, in which case it would be so immediately apparent that instinctively the reader would shift his position or the lamp slightly, in order to avoid it. With light from this single light source incident upon the page from a direction which would not result in serious glare from the paper, and with the flame shielded from the observer's eyes, the conditions for reading or other work were comparatively good. At the same time, the old oil lamp was well adapted to the illumination of a book by light from over the reader's shoulder (Fig. 9), one of the best positions for reading. It was in the comparative freedom from misuse of the oil lamp, and the conditions which its employment made natural, that the relative freedom from harmful effect was probably found, if such freedom did exist under those conditions, which is a point that has not been established. Of course, no matter how favorable conditions for vision may be, it is difficult to prevent a certain amount of carelessness or perversity in the use of the light (Fig 9). Whether it is carelessness which induces Mrs. Lux to read with her page dimly illuminated by light from the ceiling and wall, while facing the light, is open to question. Perhaps she may feel that her appearance is more attractive with the light full upon her face.

Wall brackets may be employed with good effect if equipped discreetly. For utilitarian purposes they are of value chiefly in providing local illumination. It is very difficult to light a room solely from wall brackets (Fig. 10). The light cannot be distributed satisfactorily in the room without placing light sources immediately within the range of vision. Wall brackets find best application when employed in rooms in which the main illumination is provided otherwise and the brackets are equipped with decorative shades, the installation serving as ornament rather than for use.

Daylight, being that under which the human eye has been evolved, may be expected to possess the qualities for which the eye is best adapted.

Direct lighting, in which the great bulk of the light utilized comes directly from the light source, had been abused with detrimental results. Particularly was it lacking in diffusion. Indirect lighting is the other extreme, possessing in a high degree the element of diffusion which is so often lacking in direct lighting systems. The rapid growth of indirect lighting is the manifestation of a protest against abuse of direct lighting. Its effect has been to introduce into direct lighting practice a considerable general improvement, which has corrected, or decreased some of the evils of direct lighting. And too much credit cannot be given to the exploiters of indirect lighting devices for the beneficial influence which they have exerted upon our lighting practice in general.

In the lighting fixtures here shown (Fig. 7), the lamp in the metal bowl is backed by an efficient mirrored reflector, which directs its light toward the ceiling. The rooms have been equipped with three ceilings; one is white, and has about as high a reflecting coefficient as is likely to be found in practice. Another is cream colored, and reflects a smaller proportion of the light. A third is dark cream, approaching a tan, and reflects still less of the light. This latter is about as dark as one might expect to find employed in an indirect lighting system, where any attention is paid to efficiency. Indirect lighting is so largely dependent upon the reflecting qualities of the ceiling, that the statistics of the illumination intensities in these rooms are of interest. The horizontal illumination intensity on the table plane averages for the three ceilings:

White ceiling	100 per cent
Light cream ceiling[1]	87 per cent
Dark cream ceiling	58 per cent

Showing a reduced efficiency of 42 per cent due to the inferior reflecting qualities of the darker ceiling.

Following closely upon the development of the indirect lighting system, come systems classed inaccurately as semi-indirect lighting units, in which part of the light is reflected from the ceiling, as in the indirect system, while part of it comes directly from the translucent bowl surrounding the light source. It is obvious, of course, that with any translucent lighting auxiliary employed in a direct lighting system, some of the light which reaches the ceiling and walls, is reflected downward, and that the system is thus a semi-indirect system. Those units which are classed as semi-indirect units at the present time are, however, units designed especially with a view to directing a considerable proportion of the light toward the ceiling. The most desirable combination of direct and indirect light for general purposes served by such units, is to-day a subject of discussion. Views of illuminating engineers vary in this matter. All kinds of relations between these two components are to be found represented by outfits now available in the open market. These range from equipments in which the transmitted light is so small a proportion of the total as to make it apparent that the purpose to be served by the direct component is chiefly one of decoration, to those in which the direct component is so large as to make evident an intention to increase the efficiency considerably by restricting the amount of light which is subjected to the inherent ceiling loss.

In the photograph (Fig. 8) three semi-indirect lighting fixtures are shown. In room No. 1, a direct lighting reflector is inverted. In room No. 3, a bowl, not intended for this purpose, is employed. The design of its surfaces is not well adapted to this purpose, and it is therefore not so efficient as it might otherwise be made. In room No. 2 a hemisphere is utilized, illustrating semi-indirect lighting in the simplest of its characteristic forms.

It is a matter for gratification that illuminating engineers to-day have such an excellent choice as that afforded by the wide range of available equipments for direct, indirect and semi-indirect lighting systems. Each has its merits, each its demerits. In some installations, one type is preferable, in other installations, some other type may produce most desirable results. The good qualities which characterize each are coming to be incorporated, as far as practicable, in the others, and it may be noted that the more vigorously each system is exploited, the more beneficial upon lighting practice in general will the result be. With a direct lighting system, it is a simple matter to direct a relatively large percentage of the light downward upon say the table plane, but it is a difficult matter to so dispose the lamps and to so equip them that the installation will be free from troubles due to glare and shadow. With an indirect lighting system it is relatively a simple matter to avoid deleterious effects due to glare and shadow, but it is very difficult to direct a satisfactorily large percentage of the light upon the table plane. Where absence of glare and shadow is a consideration of paramount importance, an indirect or a semi-indirect lighting system may often be preferable, in spite of the necessity for somewhat greater expenditure in energy. Where these considerations are not so important, or where economy of operation is the prime consideration, a direct lighting system may prove preferable. In any case, the adroitness of the illuminating engineer may exhibit itself in securing the best balance between economy on the one hand and absence of glare and shadow on the other. As to the appearance of the installations, there may be all kinds of diverse views, and we must remember that there is no disputing taste. Obviously it is difficult to discuss those phases of the question when dealing with the subject in a general way.

[1] It was discovered too late for correction that the light cream ceiling has diffusing qualities so unlike the dark cream ceiling that in spite of reasonably typical intensities on the table plane, the appearance as viewed from without the rooms is not consistent with the intensity figures shown; thus, the ceiling in Room 2, when viewed from the table, is much lighter than the ceiling in Room 3, though it does not appear in the figures.

The three modern systems of lighting are represented in Fig. 12. In room No. 1, the direct lighting unit transmits sufficient light to make the walls pleasantly, but not objectionally, bright, while directing much of the light to the table plane. In room No. 2, the semi-indirect unit illuminates the card by light direct from the bowl and by light from the ceiling and walls in something like the proportions of 3 to 1. The relative direct and indirect components upon the table plane are of the order of 1½ to 1. In room No. 3 all of the light is diffused from the ceiling. The ceiling is the brightest surface within view, the lamp being entirely concealed. The illumination is very soft and uniform.

Comparing the two end rooms, it will be noted that in room No. 1, the vertical stripes in the wall-paper may be seen standing out clear and sharp. The character of the pattern is evident. In room No. 3 these stripes are seen somewhat less distinctly. This is due to the lower intensity of light on the wall. Still more important, however, as a factor, is the downward direction of the light from the ceiling. Viewed from the table, these stripes stand out distinctly as the angle and direction are then such as to be within the zone of strong specular reflection from the wall-paper. Viewed as in the photograph, these stripes can hardly be discerned except on the upper part of the walls near the border. The paper loses its character. This is an excellent illustration of the importance of securing proper direction from the major part of the light, although it should not be taken as an indication that the direction is wrong in this installation because it must be remembered that the effect would be minimized if the wall-paper were viewed from within the room, instead of from without.

With the conditions as established (and it is not claimed that they are more than suggestive of typical conditions) the card illuminations are as follows:

Room No. 1	220 per cent
Room No. 2	100 per cent
Room No. 3	42 per cent

It must be remembered, however, that the direct lighting unit in this case is favored, because the card is immediately beneath it at the point of highest intensity. For purposes of reading, as an example, it is difficult to judge from these figures as to the relative useful light. In the first place, questions of diffusion may result in establishing demands for higher intensities in one system than in another. This is one of the questions which is being very generally investigated at the present time, and in such a review as this, its discussion has no place. Dealing solely with the question of distribution, it may be noted that most reading would be likely to be done near the center of the room and that therefore the direct lighting system should receive some of the advantage in rating which the high intensity of the card immediately beneath the unit would appear to give it. The relative higher intensities in the corners of the room with the indirect, and to a lesser degree with the semi-indirect fixture, are not of much advantage from a practical standpoint. In this particular installation, with the same flux produced by the lamps in each type of lighting, the average horizontal intensities are relatively:

Direct lighting	1.61 foot-candles
Semi-indirect lighting	1.33 foot-candles
Indirect lighting	0.91 foot-candles

It is generally believed that with conditions suitable for each system of lighting, the direct lighting system will deliver about twice as much light upon the table plane as does the indirect lighting system, while each will illuminate the walls moderately.

The decorative feature has kept pace with developments in the other branches of the art. Lighting auxiliaries are consistently being improved in appearance, as well as in other features of effectiveness. Efficiency of reflection, the necessary degree of diffusion, and the proper direction of light are being achieved more and more completely as experience becomes greater. In good taste and other qualities that make for pleasing effects, constant advances are being made also.

In Fig. 13 may be seen illustrations of some of the more decorative types of fixtures and glassware now available in standard types. Whatever the character of the installation may be, it is more than likely that unless it is extraordinary, some fixture and some kind of glassware may be obtained which may be used in the installation with fair satisfaction. Unless installations are considered which are so unusual as to demand the design of special lighting equipments, those now obtainable must be considered to afford a very satisfactory range of selection.

The population of Morocco has recently been estimated by M. de Caix, on the basis of an actual census of one district and the information that has been rapidly accumulating concerning the country at large. M. de Caix thinks the total cannot exceed 3,000,000, as compared with the estimates of from ten to thirty million that were once current.

Our Fighting Strength

Armored Ships of the United States Navy

Class.	NAME.	Displacement.	Length.	Beam.	Draught.	Indicated Horse-Power.	Where built.	Date of Launch.	Date of Completion.	Armor.						Armament.		Speed.	Coal. Normal and Maximum.	Complement.
										Belt.	Deck.	Side above Belt.	Bulk-head.	Gun Position. Heavy Guns.	Gun Position. Secondary.	Guns.	Torpedo Tubes.			
b.	**Alabama**	tons. 11,552	ft. 368	ft. 72¼	ft. 23½	11.207 *t*	Philadelphia.	1898	1900	in. 16½–4 H.S.	in. 2¾–4	in. 5¼ H.S.	in. 12 H.S.	in. 15 H.S.	in. 6 H.S.	4 *13-in.*, 14 *6-in.*, 4 *3-in.*, 4 *6-pr.*, 2 *1-pr.*, 4 M., 2 l	..	knots. 17.0 *t*	tons. 800 / 1447	592
b.	**Arkansas**	26,000	554	93¼	28½	28,000 tur.	Camden, N. J	1911	....	11–9 K.S.	.....	.....	8–6 K.S.	11 K.S.	8	12 *12-in.*, 21 *5-in.*, 4 *3-pr.*, 2 M., 2 l.	2 (sub.)	21.0	1650 / 2699	1115
e.	**Brooklyn**	9,215	400½	64¾	24	18,425 *t*	Philadelphia.	1895	1896	3 H.S.	6–3	4 H.S.	.....	8 H.S.	5½ H.S.	8 *8-in.*, 12 *5-in.*, 4 *6-pr.*, 4 *1-pr.*, 4 M., 2 l.	..	21.9 *t*	900 / 1350	718
a.c.	**California**	13,680	502	69½	24	29,381*t* B.&W.	S.Francisco	1904	1907	6–3½ K.S.	4	5 K.S.	4 K.S.	6 K.S.	5 K.S.	4 *8-in.*, 14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 8 *1-pr.*, 8 M., 2 l.	2 (sub.)	22.2 *t*	900 / 2185	829
e.	**Charleston**	9,700	424	66	22½	27,200 B.&W.	Newport News	1904	1906	4 H.S.	3	4 H.S.	.....	4 H.S.	.....	14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 12 *1-pr.*, 10 M., 2 l.	..	22.0	650 / 1776	664
a.c.	**Colorado**	13,680	502	69½	24	26,837 Nic.	Philadelphia.	1903	1905	6–3½ K.S.	4	5 K.S.	4 K.S.	6 K.S.	5 K.S.	4 *8-in.*, 14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 8 *1-pr.*, 8 M., 2 l.	2 (sub.)	22.2 *t*	900 / 1929	829
b.	**Connecticut**	16,000	450	76¾	24½	20,525 B.&W.	Camden, N.J.	1904	1906	11½ K.S.	3	8 K.S.	7 K.S.	10 K.S.	7 K.S.	4 *12-in.*, 8 *8-in.*, 12 *7-in.*, 20 *3-in.*, 4 *3-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	18.8 *t*	900 / 2452	803
b.	**Delaware**	20,000	510	85¼	27	29,025	Newport News	1909	1910	11 K.S.	.....	10–8 K.S.	.....	11 K.S.	5 K.S.	10 *12-in.*, 14 *5-in.*, 4 *3-pr.*, 2 l., 12 M.	2 (sub.)	21.5 *t*	1000 / 2668	927
b.	**Florida**	21,825	510	88¼	28½	28,000 tur.	New York	1910	1911	11	.....	10	.....	11	5	10 *12-in.*, 16 *5-in.*, 4 *3-pr.*, 4 M., 2 l.	2 (sub.)	22.1 *t*	1000 / 2500	1014
b.	***Georgia**	14,948	435	76¼	23¾ †	25,088*t* Nic.	Bath, Me	1904	1906	11–4 K.S.	3	6 K.S.	6 K.S.	11 K.S.	6 K.S.	4 *12-in.*, 8 *8-in.*, 12 *6-in.*, 12 *3-in.*, 4 *6-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	19.2 *t*	900 / 1967	812
b.	**Idaho**	13,000	375	77	24¾	14,235 B.&W.	Philadelphia.	1905	1908	9–4 K.S.	3–1½	7 K.S.	7 K.S.	10–7½ K.S.	6 K.S.	4 *12-in.*, 8 *8-in.*, 8 *7-in.*, 12 *3-in.*, 4 *6-pr.*, 4 *1-pr.*, 8 M., 2 l.	2 (sub.)	17.2 *t*	600 / 1824	725
b.	**Illinois**	11,552	368	72¼	23½	12,757	Newport News	1898	1901	16½–4 H.S.	2¾–4	5¼ H.S.	12 H.S.	15 H.S.	6 H.S.	4 *13-in.*, 14 *6-in.*, 4 *3-in.*, 4 *6-pr.*, 6 *1-pr.*, 4 M., 2 l.	....	17.45 *t*	800 / 1275	686
b.	**Indiana**	10,288	348	69¼	24	9,607 B.&W.	Philadelphia.	1893	1895	18 H.S.	2¾	5 H.S.	17 H.S.	17 H.S.	10 H.S.	4 *13-in.*, 8 *8-in.*, 12 *3-in.*, 4 *6-pr.*, 2 M., 1 l.	....	15.5 *t*	400 / 1500	497

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* Superposed turrets.

† Mean draught.

Class.	NAME.	Displacement.	Length.	Beam.	Draught.	Indicated Horse-Power.	Where built.	Date of Launch.	Date of Completion.	Armor.						Armament.		Speed.	Normal and Maximum Coal Supply.	Complement.
										Belt.	Deck.	Side above Belt.	Bulk-head.	Gun Position. Heavy Guns.	Gun Position. Secondary	Guns.	Torpedo Tubes.			
		tons.	ft.	ft.	ft.					in.	in.	in.	in.	in.	in.			knots.	tons.	
b.	**Iowa**	11,364	360	72¼	24	11,933	Philadelphia.	1896	1897	14 H.S.	2¾	5 H.S.	12 H.S.	15 H.S.	8–6 H.S.	4 *12-in.*, 8 *8-in.*, 10 *4-in.*, 4 *6-pr.*, 6 M., 2 l.	....	17.1 *t*	625 / 1643	520
b.	**Kansas**	16,000	450	77	24½	19,545 B.&W	Camden, N.J.	1905	1907	8–11 K.S.	3–4½	8 K.S.	7 K.S.	10 K.S.	7 K.S.	4 *12-in.*, 8 *8-in.*, 12 *7-in.*, 20 *3-in.*, 4 *6-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	18.1 *t*	900 / 2388	854
b.	*Kearsarge	11,520	368	72¼	23½	(11,788 / 12,179)	Newport News	1898	1899	16½–4 H.S.	2¾–5	5½ H.S.	.....	15 H.S.	9 H.S.	4 *13-in.*, 4 *8-in.*, 18 *5-in.*, 4 *6-pr.*, 8 *1 pr.*, 4 M., 2 l.	1 /	*t* 16.8 / 16.9 *t*	410 / 1640 / 1620	690 / 686
b.	*Kentucky																			
b.	**Louisiana**	16,000	450	76¾	24½	20,748 B.&W.	Newport News.	1904	1906	11–8 K.S.	3	8 K.S.	7 K.S.	10 K.S.	7 K.S.	4 *12-in.*, 8 *8-in.*, 12 *7-in.*, 20 *3-in.*, 4 *6-pr.*, 8 *1-pr.*, 8 M., 2 l.	4	18.8 *t*	900 / 2389	803
b.	**Maine**	12,500	388	72¼	23¾	15,693 Nic.	Philadelphia.	1901	1902	11–4 K.S.	2¾–4	6 K.S.	10 K.S.	12 K.S.	6 K.S.	4 *12-in.*, 16 *6-in.*, 6 *3-in.*, 4 *3-pr.*, 6 *1-pr.*, 2 M., 2 l.	2 (sub.)	18.0 *t*	1000 / 1860	551
a.c.	**Maryland**	13,680	502	69½	24	28,059 B.&W.	Newport News.	1903	1905	6–3½ K.S.	4	5 K.S.	4 K.S.	6 K.S.	5 K.S.	4 *8-in.*, 14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 8 *1-pr.*, 8 M., 2 l.	2 (sub.)	22.4 *t*	900 / 2054	829
b.	**Massachusetts**	10,288	348	69¼	24	10,240	Philadelphia.	1893	1896	18 H.S.	2¾	5 H.S.	17 H.S.	17 H.S.	10–5 H.S.	4 *13-in.*, 8 *8-in.*, 12 *3-in.*, 4 *6-pr.*, 2 M., 2 l.	....	16.2 *t*	400 / 1487	509
b.	**Michigan**	16,000	450	80¼	24½	16,310 B.&W.	Camden, N. J	1908	1909	11–9	3	8	10	10–8	8	8 *12-in.*, 22 *3-in.*, 4 *3-pr.*, 12 M., 2 l.	2 (sub.)	18.8 *t*	900 / 2380	669
e.	**Milwaukee**	9,700	424	66	22½	24,166 W.T.	S. Francisco.	1904	1906	4 H.N.S.	3	4 H.N.S.	.....	4 H.N.S.	.....	14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 12 *1-pr.*, 10 M., 2 l.	....	22.2 *t*	650 / 1704	664
b.	**Minnesota**	16,000	450	77	24½	20,235 B.&W.	Newport News.	1905	1907	8–11 K.S.	3–4½	8 K.S.	7 K.S.	10 K.S.	7 K.S.	4 *12-in.*, 8 *8-in.*, 12 *7-in.*, 20 *3-in.*, 4 *6-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	18.8 *t*	900 / 2364	881
b.	**Mississippi**	13,000	375	77	24¾	13,607 B.&W.	Philadelphia.	1905	1908	9–4 K.S.	3–1½	7 K.S.	7 K.S.	10–7½ K.S.	6 K.S.	4 *12-in.*, 8 *8-in.*, 8 *7-in.*, 12 *3-in.*, 4 *6-pr.*, 4 *1-pr.*, 8 M., 2 l.	2 (sub.)	17.11 *t*	600 / 1824	725
t.	**Missouri**	12,500	388	72¼	24	15,845 T.	Newport News.	1901	1903	12–4 K.S.	2¾–4	6 K.S.	10 K.S.	12 K.S.	6 K.S.	4 *12-in.*, 16 *6-in.*, 6 *3-in.*, 4 *3-pr.*, 4 *1-pr.*, 2 M., 2 l.	2 (sub.)	18.1 *t*	1000 / 1887	551
a.c	**Montana**	14,500	502	73	25	27,938 B.&W.	Newport News.	1906	1908	5–3 K.S.	3	5 K.S.	6 K.S.	9 K.S.	5 K.S.	4 *10-in.*, 16 *6-in.*, 22 *3-in.*, 4 *6-pr.*, 4 *1-pr.*, 4 M., 2 l.	4 (sub.)	22.3 *t*	900 / 2113	845

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*Superposed turrets.

d.	**Monterey**	4,084	256	59	14¾	5244 B.&W.	S. Francisco.	1891	1893	13–6 H.S.	3	.....	.....	13 H.S.	.....	2 *12-in.*, 2 *10-in.*, 6 *6-pr.*, 4 *1-pr.*, 2 M.	....	13.6 *t*	200 / 206	218
b.	***Nebraska**	14,948	435	76¼	23¾ †	21,283 B.&W.	Seattle	1904	1907	11–4 K.S.	3	6 K.S.	6 K.S.	11 K.S.	6 K.S.	4 *12-in.*, 8 *8-in.*, 12 *6-in.*, 12 *3-in.*, 4 *6-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	19.1 *t*	900 / 1923	812
b.	**Nevada**	27,500	575	95¼	28½	.....	Quincy, Mass	.....	.....	.....	.....	.....	.....	.....	.....	10 *14-in.*, 21 *5-in.*, 4 *3-pr.*	4 (sub.)	20.5	§2000	
b.	**New Hampshire**	16,000	450	77	24½	19,100 B.&W.	Camden, N.J.	1906	1908	9–4 K.S.	3	7 K.S.	7 K.S.	12 K.S.	7 K.S.	4 *12-in.*, 8 *8-in.*, 12 *7-in.*, 20 *3-in.*, 4 *6-pr.*, 4 *1-pr.*, 4 M., 2 l.	4 (sub.)	18.2 *t*	900 / 2592	916
b.	***New Jersey**	14,948	435	76¼	23¾ †	23,089 B.&W.	Quincy, Mass	1904	1906	11–4 K.S.	3	6 K.S.	6 K.S.	11 K.S.	6 K.S.	4 *12-in.*, 8 *8-in.*, 12 *6-in.*, 12 *3-in.*, 12 *3-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	19.4 *t*	900 / 1900	812
b.	**New York**	27,000	565	95¼	28½	35,000	New York	1912	....	11–5 K.S.	3	9	.....	11 K.S.	5 K.S.	10 *14-in.*, 21 *5-in.*, 4 *3-pr.*	4 (sub.)	21.0	2850	
a.c.	**North Carolina**	14,500	502	73	25	29,785 B.&W.	Newport News.	1906	1908	5–3 K.S.	3	5 K.S.	9 K.S.	9 K.S.	5 K.S.	4 *10-in.*, 16 *6-in.*, 22 *3-in.*, 4 *6-pr.*, 4 *1-pr.*, 4 M., 2 l.	4 (sub.)	22.48 *t*	900 / 2113	845
b.	**North Dakota**	20,000	510	85¼	27	31,400 Cur.tur.	Quincy, Mass	1908	1910	11 K.S.	.....	10–8 K.S.	....	11 K.S.	5 K.S.	10 *12-in.*, 14 *5-in.*, 4 *3-pr.*, 2 l., 12 M.	2 (sub.)	21.0 *t*	1000 / 2676	960
b.	**Ohio**	12,500	388	72¼	23½	16,220 T.	S. Francisco.	1901	1904	11–4 K.S.	3–4	6 K.S.	10 K.S.	12 K.S.	6 K.S.	4 *12-in.*, 16 *6-in.*, 6 *3-in.*, 4 *6-pr.*, 6 *1-pr.*, 2 M., 2 l.	2 (sub.)	17.8 *t*	1000 / 2277	521
b.	**Oklahoma**	27,500	575	95¼	28½	.....	Camden, N.J.	.....	.....	.....	.....	.....	.....	.....	.....	10 *14-in.*, 21 *5-in.*, 4 *3-pr.*	4 (sub.)	20.5	§2000	
b.	**Oregon**	10,288	348	69¼	24	11,037	S. Francisco.	1893	1896	18 H.S.	2¾	5 H.S.	17 H.S.	17 H.S.	10–5 H.S.	4 *13-in.*, 8 *8-in.*, 12 *3-in.*, 4 *6-pr.*, 2 *1-pr.*, 4 M.	....	16.8 *t*	400 / 1425	500
b.	**Pennsylvania**	31,400	600	97	28¾	.....	Newport News.	.....	.....	.....	.....	.....	.....	.....	.....	12 *14-in.*, 22 *5-in.*, 4 *3-pr.*	4 (sub.)	21.0	§2322	
a.c.	**Pittsburgh**	13,680	502	69½	24	28,600 Nic.	Philadelphia.	1903	1905	6–3½ K.S.	4	5 K.S.	4 K.S.	6 K.S.	5 K.S.	4 *8-in.*, 14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 8 *1-pr.*, 8 M., 2 l.	2 (sub.)	22.4 *t*	900 / 1946	829
b.	***Rhode Island**	14,948	435	76¼	23¾ †	20,310 B.&W.	Quincy, Mass	1904	1906	11–4 K.S.	3	6 K.S.	6 K.S.	11 K.S.	6 K.S.	4 *12-in.*, 8 *8-in.*, 12 *6-in.*, 12 *3-in.*, 4 *6-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	19.0 *t*	900 / 1900	812
e.	**Saratoga**	8,150	380½	64¾	23¼	17,075	Philadelphia.	1891	1893 1909	4 H.S.	2½	..... K.S.	.....	6½ H.S.	5–4 H.S.	4 *8-in.*, 10 *5-in.*, 8 *3-in.*, 4 *3-pr.*, 4 M.	....	21.0 *t*	750 / 1075	498
e.	**St. Louis**	9,700	424	66	22½	27,264 B.&W.	Philadelphia. (Cramp)	1905	1906	4 K.S.	3	4–3	.....	4 K.S.	.....	14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 12 *1-pr.*, 10 M., 2 l.	....	22.1 *t*	650 / 1751	664
b.	**South Carolina**	16,000	450	80¼	24½	18,357 B.&W.	Philadelphia. (Cramp)	1908	1909	11–9	3	8	10	10–8	8	8 *12-in.*, 22 *3-in.*, 2 *3-pr.*, 12 M., 2 l.	2 (sub.)	18.9 *t*	900 / 2200	669
a.c.	**South Dakota**	13,680	502	69½	24	28,598 B.&W.	S. Francisco.	1904	1907	6–3½ K.S.	4	5 K.S.	4 K.S.	6 K.S.	5 K.S.	4 *8-in.*, 14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 8 *1-pr.*, 8 M., 2 l.	2 (sub.)	22.2 *t*	900 / 2185	829

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*Superposed turrets. † Mean draught. § Tons of oil fuel.

Class.	NAME.	Displacement.	Length.	Beam.	Draught.	Indicated Horse-Power.	Where built.	Date of Launch.	Date of Completion.	Armor. Belt.	Armor. Deck.	Armor. Side above Belt.	Armor. Bulkhead.	Armor. Gun Position. Heavy Guns.	Armor. Gun Position. Secondary.	Armament. Guns.	Armament. Torpedo Tubes.	Speed.	Normal and Maximum Coal Supply.	Complement.
		tons.	ft.	ft.	ft.					in.	in.	in.	in.	in.	in.			knots.	tons.	
a.c.	**Tennessee**	14,500	502	72¾	25	26,963 B.&W.	Philadelphia.	1904	1906	5–3 K.S.	3	5 K.S.	6 K.S.	9 K.S.	5 K.S.	4 *10-in.*, 16 *6-in.*, 22 *3-in.*, 4 *3-pr.*, 4 *1-pr.*, 8 M., 2 l.	4 (sub.)	22.2 *l*	900 1974	858
b.	**Texas**	27,000	565	95¼	28½	35,000	Newport News.	1912	.....	11–5 K.S.	3	9 K.S.	.....	11 K.S.	5 K.S.	10 *14-in.*, 21 *6-in.*, 4 *3-pr.*	4 (sub.)	21.0	2892	
b.	**Utah**	21,825	510	88¼	28½	28,000 tur.	Camden, N.J.	1909	1911	11	.....	10	.....	11	5	10 *12-in.*, 16 *6-in.*, 4 *6-pr.*, 4 M., 2 l.	2 (sub.)	21.0	1000 2520	1014
b.	**Vermont**	16,000	450	77	24½	17,982 B.&W.	Quincy, Mass	1905	1907	8–11 K.S.	3–4½	8 K.S.	7 K.S.	10 K.S.	7 K.S.	4 *12-in.*, 8 *8-in.*, 12 *7-in.*, 20 *3-in.*, 4 *6-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	18.33 *l*	900 2428	854
b.	***Virginia**	14,948	435	76¼	23¾ †	22,841 Nic.	Newport News.	1904	1906	11–8 K.S.	3	6 K.S.	6 K.S.	11 K.S.	6 K.S.	4 *12-in.*, 8 *8-in.*, 12 *6-in.*, 12 *3-in.*, 4 *6-pr.*, 8 *1-pr.*, 8 M., 2 l.	4 (sub.)	19.0 *l*	900 1924	812
a.c.	**Washington**	14,500	502	72¾	25	27,152 B.&W.	Camden, N.J.	1905	1906	5–3 K.S.	3	5 K.S.	6 K.S.	9 K.S.	5 K.S.	10 *10-in.*, 16 *6-in.*, 22 *3-in.*, 4 *3-pr.*, 4 *1-pr.*, 8 M., 2 l.	4 (sub.)	22.3 *l*	900 2015	858
a.c.	**West Virginia**	13,680	502	69½	24	26,135 B.&W.	Newport News.	1903	1905	6–3½ K.S.	4	5 K.S.	12 H.S.	6 K.S.	5 K.S.	4 *8-in.*, 14 *6-in.*, 18 *3-in.*, 4 *3-pr.*, 8 *1-pr.*, 8 M., 2 l.	2 (sub.)	22.1 *l*	900 2054	829
b.	**Wisconsin**	11,552	368	72¼	23½	12,452	S. Francisco.	1898	1901	16½–4 H.S.	3–4	5¼ H.S.	.....	15 H.S.	6 H.S.	4 *13-in.*, 14 *6-in.*, 4 *3-in.*, 4 *6-pr.*, 6 *1-pr.*, 4 M., 2 l.	....	17.2 *l*	800 1413	583
b.	**Wyoming**	26,000	554	93¼	28½	28,000 tur.	Philadelphia.	1911	1912	11–9 K.S.	.....	.....	8–6 K.S.	11 K.S.	8	12 *12-in.*, 21 *5-in.*, 4 *3-pr.*, 2 M., 2 l.	2 (sub.)	21.2	1650 2500	1115
b.	**Battleship No. 39**	31,400	600	97	28¾	.....	New York ...	Bldg	.....	.....	.....	.....	.....	.....	.....	12 *14-in.*, 22 *5-in.*, 4 *3-pr*	4 (sub.)	21.0	2322	

Also the Monitors Amphitrite, Miantonomoh, Monadnock, and Terror, 3990 tons, Tonopah (*ex* Nevada), 3225 tons, Cheyenne (*ex* Wyoming), 3225 tons. *Superposed turrets. †Mean draught.

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Flavor of Butter Injured by Metals

Economic conditions make it necessary at present to hold butter in storage from the summer season, when it is plentiful, to the winter season, when it is scarce. If the butter is properly made this can be done without materially injuring its quality. It often occurs, however, that butter which has been held in storage for some months develops disagreeable flavors that greatly lessen its value. These bad flavors that will often pass unnoticed when the butter is fresh may become so serious a defect after three or four months in storage as to render the butter almost unsalable. The chemical changes which cause these bad flavors are often too small to be detected by the ordinary analytical methods of the laboratory, but the senses of smell and taste are far more delicate, and as soon as bad flavors are detected by them the value of the product is lessened.

Some metals either cause or greatly accelerate certain bad flavors in butter, although most of the experiments along this line have not included storage butters. Recently the scientific staff of the Dairy Division of the Bureau of Animal Industry in the United States Department of Agriculture has reported that the presence of very small amounts of iron in cream causes certain undesirable flavors to increase in intensity during storage. These flavors are often designated by butter experts as "metallic," "oily," or "fishy." The injurious effect of iron was found by adding iron in known quantities, varying from 1 to 500 parts, to a million parts of cream. The butter made from such cream was compared with that made from cream where all precautions were taken to avoid any undue contact with iron during the whole process of butter making. The butter was stored at 6 deg. Fahr. to 10 deg. Fahr. and the quality of the butter was scored by experts at different times. In every instance when the butter was scored a few days after making, the samples to which iron had been added scored lower than the butter made from cream which contained no iron. This held true in most cases on the second and third scoring, which occurred at intervals varying from 20 to 187 days. The most noticeable feature was the rapid development of bad flavor in the butter containing the iron. When both the control and the experimental butter became fishy it was noticed that the control butter was the last to become so. There was a marked oily flavor present in most samples that subsequently became fishy. Only a small proportion of the iron added to the cream was found in the butter, the remainder having been taken up by the buttermilk and wash water.

Butter was also made from cream which had stood in rusty cans, and in every case this butter had a peculiar taste and was easily picked out from all other samples. The buttermilk also had a decided metallic taste.

The influence of copper on the flavor of butter was studied in a similar manner, and it was found that copper, even in small quantities, seemed to cause more marked changes of flavor in butter than did the iron, with a decided tendency toward a fishy flavor in storage. Two experiments showed very plainly the harmful effect of using poorly tinned pasteurizers, even though the cream came in contact with the copper surface for only a few seconds, for, aside from this, all other conditions were exactly alike during the complete process of butter manufacture.

This work shows that if cream is kept in rusty cans or comes in contact with iron or copper at any time during the process of butter making it may take up iron or copper from rusty cans, exposed bolt heads, or other metal parts of pasteurizers or churns, in sufficient quantities to affect the flavor of storage butter. Though there is nothing to show that the nature of the flavor is appreciably changed, it does demonstrate very clearly that the rate of development of the undesirable flavor is greatly accelerated during storage by very small quantities of either iron or copper.—*The Chemical Engineer.*

America Beats Europe in Price War.—For several months the automobile world has been stirred by what was termed a price war between American and European manufacturers. When it was announced that a number of foreign car builders intended to engage in the manufacture of low priced machines to compete with the enormous import of American built cars, experts declared that it would be impossible for them to do so on account of the great difference in factory methods. It would be several years before European makers could produce cars or parts in quantities as is done in this country. That foreign competitors have come to realize this is proven by the fact that the Union of International Automobile Constructors, at its meeting in Geneva on July 8th, decided that, an account of American factory methods of quantity production with the use of special machines, the production of the same class of machine at the same price was impossible.

What Are the Ten Greatest Inventions of the Age, and Why?

Scientific American Prize Contest: Essay Which Received Honorable Mention

By "Idline" (Emil Schultze, Baltimore, Md.)

THE successful victory over the ether, the conquest of the air, the supremacy on the seas, the annihilation of time and space, and the evolution of the motor mark a new era of our time. Ten great inventions, the work of, master minds, have accomplished this modern miracle, and while the greater part of these inventions has been built on foundations laid years ago, we are only now enjoying the fruits of their labor.

To William Marconi, the wireless wizard.
Thomas Edison, the father of the phonograph.
The Wright Brothers and their flying machine.
Frank J. Sprague and his electric car.
Paul Herault and his improved electric furnace.
The Lumière Brothers of cinematograph fame.
Gottlieb Daimler and his explosive motor.
Charles Parsons and his steam turbine.
Ottmar Mergenthaler with his linotype, and
Joseph Manier, the originator of re-enforced concrete,

we are everlastingly grateful for their inventive genius which added so much to the welfare and comfort of mankind.

In the discovery of the X-rays by Wilhelm Röentgen in 1895 and the isolation of Radium by the Curies in 1898, additional blessings have been ours. It may be that future inventors will give to the world the new light that emanates from this radio-active metal thus opening up an unexplored field of light, heat and power, and blazing the way for the coming Radium Age.

William Marconi stands today as the acknowledged leader in wireless telegraphy made possible by his inventions. In 1889 Henry Hertz observed that the electric waves could be sent out in all directions, just as light waves go out in all directions. He also demonstrated how these waves may be produced, how detected or caught as they pass through space. In 1890 Marconi made use of this fact by sending a message some distance without wire. In 1902 while on board the Philadelphia steaming towards America he received messages from Poldhu up to fifteen-hundred and fifty miles and signals up to two-thousand miles. In 1903 he sent his famous message in the shape of greetings from President Roosevelt to King Edward, a distance of twenty-five hundred miles, convincing all that there existed no positive limit to the distance that might be covered by the Marconi system, the strength of the current set up and the reliability of the instruments being the determinating factors. This invention is now used in signaling from all sea-going vessels, thus keeping all in direct communication with each other. It will be of use in transmitting messages from and to aeroplanes, moving trains and its utility has no limit.

The perfected phonograph is one of Thomas Edison's successes. Noting the crudity of one of Leon Scott's instruments for recording vibration of sounds, he conceived the idea of reproducing the human voice and other sounds by causing a stiff bristle on a vibrating diaphragm to indent a coated cylinder. This cylinder thus receiving a record of the vibrations of the various sounds was made to reproduce them by causing the diaphragm to be vibrated again as the cylinder was rotated. This machine was modified by E. Berliner who employed a rotating disk for the record. This machine is the gramophone of to-day and is used all over the world. Many thousand machines are to-day recording all leading operas, lectures, court proceedings, etc. The recording telephone, still in its infancy, was made possible by combining both instruments, but the day will not be distant when the recording telephone will become a necessity.

Hiram Maxim stands first as a persistent experimenter in aerial science, having caused a machine to lift itself upwards from the ground by its own effort without a gasbag. In obtaining the mastery of the air we are indebted to Prof. S. P. Langley for most of our knowledge of the uncertainty of aerial conditions, as set forth in his scientific contributions. But all aeroplanists, gliders and soarers have been outdone by the Wright Brothers who on December 17th, 1903 succeeded in making their first successful flight in a heavier than air machine. Wilbur Wright flew half a mile in a two-decked motor-driven machine entirely built by the brothers. It was due to their combined efforts that man is now conqueror of the air and the brothers are truely the pioneers of aerial science. The Wright machines are now used by our government in the army and navy, and is also in Europe adopted as the ideal machine. Its practical utility in carrying passengers, its great freedom when traveling, its important function as a dispatch and mail carrier, its possibility as a machine of destruction in war and its comparative small cost of construction make the aeroplane the most talked of invention of modern times.

The installation of the first successful electric railroad was due to Frank Julian Sprague who overcame most of the difficulties then existing in 1890. His invention of controlling the constant speed of electric motors and his invention of his multiple system in operating electric trains, makes him the pioneer of the modern trolley car and of all electric railroads of the world. His first installation was in Richmond; while Robert Davidson propelled an electric engine as early as 1837 on the Edinburgh and Glasgow road and Thomas Davenport constructed an electric machine in 1855 containing all the essential elements of the modern electric motor, not until Sprague showed the world the possibility of modern cheap and quick travel had this field been explored. No other construction in the electrical world has had a more rapid growth in our times, so that to-day there is hardly a city or hamlet where one does not hear the hum of the electric car at all hours of the day and night. Modern life cannot exist without it and this age is truely called the trolley age. It has rapidly developed whole sections of the country and is to-day the best means for rapid and cheap transit.

As early as 1875 Sir William Siemens predicted a great future in electric iron and steel making and he successfully experimented with the electric current in obtaining these metals directly from the ore. Later Stassano, an Italian electrician, succeeded in making a very good grade of steel by his own electrolytic process, but not until Paul Herault made known his own process in 1887, did electric steel making claim superiority over the Bessemer and open-hearth processes. The great advantage in the Herault process is that it is independent of the quality of raw material producing an equally good steel from an inferior quality of ore. The electric furnace is at a distinct advantage over others as regards the removal of sulphur and of iron oxide from the molten metal, because its atmosphere is free from the sulphur always present in the flame of coal-fired furnaces, and almost free from oxygen, because this element is quickly absorbed by the carbon and silicon of the steel and in case of arc furnaces by the carbon of the electrodes themselves and is replaced only very slowly by leakage—whereas in the Bessemer converter and open-hearth furnace a torrent of air is always rushing in. In the Herault furnace molten metal can be freed from mechanically suspended slag more perfectly, the cost of production is much less, sulphur and phosphorus is completely removed, the final product gives a better steel, remarkably ductile and contractile, free from blow holes and surface faults and is softer and forges better than crucible steel.

With the invention of the cinematograph in 1895 by the Lumière Brothers of Lyons the art of photography took a new and wonderful departure.[1] An instrument by which fifteen photographic records per second can be received on a transparent continuous film, each record representing the photographic group at a different instant from the other, these photographs thrown on a screen and many times enlarged,—was the object so successfully carried out by the Lumière Brothers. Movements too slow for comprehension or rapid observation can be quickened by increasing the rate of passing the film over the lens, and similarly, movements too rapid to be analyzed by the human eye may be made slow enough to admit perfect observation. By these means the growth of plants from seed to maturity, the progress of building a modern skyscraper, the progress of races and science all over the world may be studied. As an educational medium it ranks second to travel and books and has added great knowledge to mankind. At the present time C. Williamson of Norfolk is taking such photographs under water. His outfit consists of a floating vessel, a submersible terminal operating chamber and a collapsible flexible metallic tube connecting the vessel and the terminal operating chamber.

In our times of modern industrial progress the evolution of the vehicle plays a leading part. To the modern vehicle we owe the good roads movement in our country, and the explosive motor made this possible. Gottlieb Daimler of Camstadt, Germany, is the father of the modern automobile. It was he who brought out the first motor bicycle in 1885 and it was he who taught the world how to build the light motors that made the automobile so successful. He did more than any other inventor to develop the internal combustion motor and demonstrated the high efficiency of using explosive gas as a motive power. The Daimler motor was first adopted in France, then in Germany and finally copied everywhere. Our first American machines were crude and unreliable and it was not until 1902 that the American-made machines equaled foreign importations. Our auto industry thrived rapidly until to-day there are many thousand vehicles manufactured, including an almost endless variety of touring, pleasure and road cars, auto-trucks, trams and other conveyances, all being driven by the combustion motor. To-day these machines move along dirt and sand roads replacing horse and mule; they ford streams, climb mountain sides, turn and stop where they please, penetrate deserts and mines, travel in unworked and unexplored regions and bring back the products of newly opened fields to commerce.

With the introduction of the steam turbine, Charles A. Parsons, its inventor ushered in a new era in steam-engineering. His first practical demonstration in 1885 was soon followed by an improved machine exhibited in 1887; this was of fifty horse-power capable of making seven thousand revolutions per minute. A few years later C. G. Curtis appeared with De Laval as rivals, although the latter's machine differed somewhat in construction. In 1896 Parsons launched his Turbinia, took the record for speed at that time and created a reputation for his invention which it has held ever since. It is fast replacing the cylinder and piston method of driving propellers of all classes of marine and stationary engines. It is in operation now in many electric and engineering plants and on many ocean liners. Among its many advantages are: extreme simplicity in construction, its economy in floor space on ships and in power house, no wear in operation, no internal lubrication—therefore exhaust steam can be condensed into oil-free water and fed to boiler—no priming when water gets into the turbines, almost complete absence of vibration, steam is applied directly without intervening mechanism that evolves friction, and no dead center in any position.

In his linotype machine Ottmar Mergenthaler has given us the most perfect type-setting and type-making of the world to-day. As early as 1884 he conceived the idea of stamping the elements in type bars instead of using separate matrices, and casting the metal into them in one and the same machine. In 1890 he perfected his new machine which was placed in the office of the New York Tribune; after this demonstration linotypes were gradually introduced in large printing establishments until eighteen hundred machines were in use in 1901. In 1910 over sixteen thousand machines were operating in America and ten thousand in foreign countries. Such was the success of Mergenthaler's machine that to-day it is used in all kinds of printing, compiling newspapers, periodicals, and books of the most exacting kind. Compare the old method of type-setting, spacing and printing slowly arranging line after line, and watch a linotype operator seated at his machine merely touch the keyboard, which impulse casts, places and spaces all in one single operation, and one must marvel at the inventor's genius that made his dream possible.

Joseph Manier gave to the world the first practical demonstration of the value of re-enforced concrete. He hit upon the idea of strengthening concrete with iron and steel bars and he deserves much credit for having pushed his inventions with vigor. Other inventions brought out later were really but slight modifications of the old system first adopted by Manier in 1867. Concrete has always been used for a building material as it is easily molded, sets quickly, has considerable compressive or crushing strength, but is weak in tensile strength. But if flat surfaces, walls and floors be re-enforced with a network of steel on or under their surface, its strength will be enormously increased. It is the ideal building material of to-day and used in all structures where durability, freedom from danger of fire, and great height are desirable. On account of its great strength, walls, floorings and arches can be constructed more shallow, thus being able to carry the heaviest loads and at the same time permitting more space for light and interior dimensions.

[1] The omission of Thomas A. Edison in this connection will be criticised by our American readers.—ED.

The Gold Output of the Transvaal is steadily increasing, and that country is now responsible for considerably more than one third of the world's supply. The output of the Transvaal mines in 1911 represented a value of $170,286,718; while the value of the 1912 output was $188,613,665. The latter figure represents a profit of $63,756,095.

NEW BOOKS, ETC.

HEATING SYSTEMS. Design of Hot Water and Steam Heating Apparatus. By F. W. Raynes, Lecturer on Heating and Ventilating, the Royal Technical College, Glasgow. New York: Longmans, Green & Co., 1913. 8vo.; 328 pp.; illustrated. Price, $3.50 net.

This work presents a tolerably comprehensive consideration of the various systems of heating, with particular reference to the most modern practice. For example, hot water heating is studied from the points of view of circulation, piping for gravity apparatus, accelerated circulating systems, and forced circulating apparatus. Steam heating is dealt with at the same adequate length, and further chapters give information on heating surfaces, ventilating and indirect radiators, heat losses from buildings, etc. A feature of the volume is thirteen charts, showing the temperature to which air is warmed by indirect heaters, the capacity of circuits of low-pressure hot-water systems, the capacity of circuits of forced hot-water circulating systems, the capacity of circuits of steam-heating systems, the assumed efficiency of boilers, and the required sizes for chimneys. Another feature is the method recommended for sizing the pipes of the different systems. The economical side of the heating problem, particularly where that problem relates to industrial buildings, has received a fitting proportion of the author's time and space.

LETTERS AND RECOLLECTIONS OF ALEXANDER AGASSIZ. With a Sketch of His Life and Work. Edited by G. R. Agassiz. New York: Houghtor Mifflin Company, 1913. 8vo.; 454 pp. With portraits and other illustrations. Price, $3.50 net.

Alexander, the noted son of an illustrious father, was a many-sided man. Zoölogy claims him for his extensive and valuable collections of sea fauna; geology, for his researches into coral formation; the science of organic form, for his early studies in morphology; archaeology, for his incursions into that domain; while the world of business and finance knew him as a successful mining man who followed science as a distraction. In the biography here given us at the hands of his son we have a large body of intimate literature that, favored by the inclusion of many letters and observations from the pen of Alexander Agassiz himself, presents to us the man as he grew and developed from the thoughtful yet mischief-loving boy of Neuchâtel to the intellectual giant who brought full mead of honor to his adopted country. His profitable connection with the Calumet and Hecla mine is well known, and is the subject of a long chapter. Other chapter-headings indicative of the nature of the contents, are Three Cruises of the "Blake," the first "Albatross" expedition, the Tropical Pacific, and Mexico and Indian. The material is so presented as to be of general appeal. The correspondence with such celebrities as Darwin and Huxley is reproduced at some length. Separate charts of his expeditions, pocketed in the front and back covers, are valuable adjuncts to the work.

THE FRESHMAN AND HIS COLLEGE. A College Manual. By Francis Cummins Lockwood, Professor of English Language and Literature. Allegheny College. New York: D. C. Heath & Co., 1913. 16mo.; 156 pp.

However unjust may have been the sarcastic remark of a British newspaper to the effect that "in university matters, as in social and political affairs, America does not know where she is going, but is determined to get there"—certainly the Freshman too seldom has an intelligent idea of where he is headed for, even when his determination to "get there" is unquestionable. Prof. Lockwood, freely confessing his own waste of time during his Freshman year, has brought together in this slim volume several remarkable inspirational essays of direct bearing upon this subject. Among these is William James's illuminating utterance on "The Principle of Habit," a paper that should be read again and again by all young people. The author's introduction will go far toward influencing the Freshman to enter upon college life with definite high purposes in view. Throughout the compilation, the distinguished writers have striven to combat such poisonous phrases as "C is a gentleman's grade," and "Get by." The youth who can read these papers without a quickening of the moral pulse is lost indeed.

KEEPING THE PRINTING PLANT YOUNG. A Discussion of the Success of Permanency and Profit-Making Conditions. By Henry Lewis Bullen. Cambridge, Mass.: The Printing Art, 1910. 12mo.; illustrated.

A short paper on "Keeping the Printing Plant Young" furnished subject-matter for a title-page contest. One hundred and five examples of the pages submitted in this contest form the bulk of the volume in hand, and furnish material for nice discrimination and profitable comparison. It is stated that the jury's awards were unanimously made. This is rather surprising when we consider the scope for individual preference and the impossibility of governing the higher decisions by hard and fast standards. Personally, we regard the winning title-page as weak in color value and of a typographical make-up that, were we speaking of subject-matter, would be characterized as "dry." The wide spacing of the letters gives the words a tendenc; to run together, and the whole effect is hard upon weak eyes. However, the "uniformity of display, well placed upon the page"—a consideration which seems to have largely influenced the jury in its award—is undoubtedly a prominent merit of the composition. The submitted title-pages are, with very few exceptions, most creditable to their originators, and, bound in their present form, they will afford pleasure and profit to even the most skilled of compositors.

ROBERT FULTON, ENGINEER AND ARTIST. His Life and Works. By H. W. Dickinson, A.M.I.Mech.E. New York: John Lane Company, 1913. 8vo.; 333 pp. With numerous plates and several illustrations in the text. Price, $3 net.

Where fellow-countrymen have celebrated Fulton's achievements, they have been inclined, perhaps, to allow their enthusiasm to suppress an adequate expression of Fulton's indebtedness to previous inventions. At the other extreme, foreign writers are prone to picture him as a mere imitator and,—in reference to his negotiations with the French and English governments,—even something akin to a traitor. One of the chief merits of this latest biography is its impartiality. Another welcome feature is the story of Fulton's early career as an artist, a phase of the man about which too little has been said. The supreme physical courage of the man, too, is calculated to arouse the highest admiration, and the chronicle of his calmly "giving his head as hostage" by personally commanding his submarines and the operation of his crude torpedoes or floating mines commands a tribute of respect. The examples of his artistic skill show no mean order of talent. His pertinacity in invention and practice, starting with the crudest ideas and educating himself in the demands of the various sciences until his mental processes finally acquired the maturity that resulted in steam navigation—these growths and fruitions are fascinating reading indeed. The volume corrects some misconceptions and, the author having had a wealth of documentary evidence and first-hand assistance at his disposal, the result is a work of much value and interest.

HOW TO BUILD, EQUIP AND OPERATE A COTTON MILL IN THE UNITED STATES. New York: Frank P. Bennett & Co., 1913. 8vo.; 766 pp.; illustrated. Price, $3.

This series of papers on the construction and management of a cotton mill are reprinted from the *American Wool and Cotton Reporter*. They are grouped into four sections, the first dealing with mill buildings and power plants, the second with administration as it is concerned with processes of manufacture, the third with general information relating to bleaching, dyeing, and finishing processes, and the fourth with modern cost systems. It will be seen that the work offers a wide range of knowledge to all who are in any way interested in cotton mill operation. The many cuts show building plans, machinery and equipment, and details of machine parts, and are accompanied by clear explanations of modern practice at home and abroad.

BAUSTEINE DES WELTALLS. Atome und Moleküle. Von Dr. A. Zart. Stuttgart: Kosmos Gesellschaft der Naturfreunde, 1913: Price, 50 cents.

To those who read German this book might be recommended as a simply-worded presentation of the development of the atomic theory. It is so thoroughly up to date that it includes a very good account of Perrin's work.

THE CHEMISTRY OF PLANT AND ANIMAL LIFE. By Harry Snyder. Third Revised Edition. New York: The Macmillan Company, 1913. Price, $1.50.

In this third edition of his excellent textbook Mr. Snyder has brought his subject up to date. It is a book which will give the student in an agricultural college or one who is taking a course in agriculture, a very good grounding in elementary chemistry and the part that chemical reactions play in the growth of plants. In the new edition a sharp division has been made between the elementary principles of chemistry from an agricultural view point and the chemistry of plant and animal life. A very important part of the book are the problems, laboratory practice and the suggested collateral reading.

THE MEANING OF EVOLUTION. By Samuel C. Schmucker. New York: The Macmillan Company, 1913. Price, $1.50.

This is a plainly worded and interestingly written book in which the leading facts of Darwinism and Neo-Darwinism are set forth.

THE AIRMAN. Experiences While Obtaining A Brevet in France. By C. Mellor, R. E. With an Introduction by Maurice Farman. London and New York: John Lane, 1913. 116 pp.

Aviation is still so new that it is interesting to learn how a man becomes a pilot and what must be his qualifications before he obtains the coveted brevet. The author has given us a very entertaining account of his experiences in learning how to fly a Maurice Farman biplane in France. This book should be useful because of the detailed accounts which he gives of his mishaps and of his experiences in general.

ECONOMICS OF BUSINESS. By Norris A. Brisco, Ph.D. New York: The Macmillan Company, 1913. Price, $1.50.

Here we have an excellent textbook on modern business methods. Such a book is more or less necessary in view of the economic changes which have been produced by the modern trust. Hence the book is primarily a study not only of factory conditions, but of modern factory methods, by which time, energy and material are saved.

GUIDE TO THE STUDY OF ANIMAL ECOLOGY. By Charles C. Adams, Ph.D. New York: The Macmillan Company, 1913. 12mo.; 183 pp.; illustrated. Price, $1.25.

The number of facts of ecological significance is justly characterized by the author as bewildering. "Ecology," he avers, "is a science with its facts out of all proportion to their organization and integration." His text is not a treatise on ecology, but a guide for the beginner; hence especial pains have been taken to bring the student to an understanding of explanatory processes and of scientific methods of observation. The book is written about a basis of ecological surveying, hence in so short a work other aspects necessarily take a distinctly subordinate position.

FIRST COURSE IN ALGEBRA. By William Benjamin Fite, Professor of Mathematics in Columbia University. New York: D. C. Heath & Co., 1913. 12mo.; 285 pp.

Algebra is a means of gaining direct knowledge from indirect statements—a mathematical argument, based upon the equation, which discovers the unknown by a progressive consideration of the known. An elementary textbook must demonstrate to the student the use of algebraical principles in identifying numbers. Keeping this aim in mind, Prof. Fife addresses himself to first-year high school pupils, catering to their needs as informally as possible. As a case in point, the usual appeal to axioms in justification of certain equational operations has been omitted in favor of arguments founded on definitions of the basic operations. New and old problems abound and graphical methods are explained to a limited extent.

FABRE, POET OF SCIENCE. By Dr. C. V. Legros. With a Preface by J. H. Fabre. Translated by Bernard Miall. New York: The Century Company, 1913. 8vo.; 352 pp. Price, $3 net.

The lover of nature and the lover of literature alike will find in this intimate biography a veritable banquet of delight. The attractive, lucid style of the original has been surprisingly well rendered in the translation. Those who are familiar with the minute and discerning labors of the man Darwin termed "that inimitable observer," will welcome this masterly presentation of his life and work. Those who have not hitherto had the pleasure of his acquaintance could scarcely enter the sphere of his influence by a more inviting portal. Fabre's observation and insight was constantly discovering wealth where others saw but poverty. Dufour, for example, believed the small coleoptera found in the nest of the Cerceris wasp to be dead, and there was an end on't. Fabre revealed to astonished humanity that these little insects were merely paralyzed by a sting unerringly administered at the exact spot where the mass of the motor ganglions is concentrated; and thus the prey is delivered to the larvæ "inert but living"! Even though we may not find ourselves in sympathy with Fabre's attitude as an anti-evolutionist we must come under his charm, and acknowledge the value of his accurate and multitudinous observations and the freshness and poesy of his modes of expression. It would be difficult to point to a higher illustration of the blend of the mathematical and poetic temperaments, and humanity benefits largely by the literary products of this rare union.

THE EQUESTRIAN MONUMENTS OF THE WORLD. By Florence Cole Quinby. New York: H. C. Quinby, 165 Broadway, 1913. Price, $2.

The author of this volume has undertaken to present in a convenient and accessible form a check list of the equestrian monuments of the world. The list is confessedly incomplete, since it is stated that reliefs, quadrigas, statuettes and the like are omitted. Hence the quardirga on the Memorial Arch in Brooklyn finds no place in this record, nor the extraordinary reliefs of Lincoln and Grant within the arch. Nor, under this classification, can space be found for the masterly equestrian sculptures of the Parthenon in Athens. It is less clear why the famous bronze horses of San Marco in Venice should have been omitted. The restrictions the author made for herself have undoubtedly greatly lessened the labor of compilation, although the value of the list is correspondingly diminished. Within its limits the book shows commendable study and much research. It has been no light task to compile a list of sculptures so considerable as this, numbering, all told, 624 monuments, of which 88 are in the United States, not including some no longer existing. The check list of foreign monuments was compiled by Valentine Blacque, and has been revised, corrected and expanded for this book by Mr. and Mrs. Quinby.

THE RAILWAY LIBRARY AND STATISTICS. 1912. (Fourth Series.) A Collection of Noteworthy Addresses and Papers, Mostly Delivered or Published during the Year Named. Compiled and Edited by Slason Thompson, Director of Bureau of Railway News and Statistics. Chicago: Bureau of Railway News and Statistics. Price, 50 cents.

The papers which go to make up "The Railway Library" for 1912 teem with interesting facts masterfully expressed. They set forth the case of the railroads from their own point of view, and include such addresses as James J. Hill's "Great Adventure," and Commissioner McChord's "Safety First." The section devoted to statistics takes up about a third of the volume, and the tables there presented uphold the following remarkable statements: That European railway employees receive from one half to two thirds less than American employees; that our railroad capitalization shows but $61,508 per mile of track owned, while averaging the principal roads of Europe points to a capitalization of no less than $121,453; that the American railroad has nearly two shareholders per mile of line owned; that its passengers are carried at the rate of 1.99 cents per mile, and its freight at 7.41 mills per mile per ton, ton-mile rates in foreign countries running from 0.74 cent to 2.91 cents; that 1912 dividends amounted to but 3½ per cent of the capital stock; and, finally, that in a comparison of accidents with those of European railways, duly taking into consideration the miles of line in operation, and the longer average movements of passengers and freight, the American record for safety surpasses that of the European roads. These, at least, are the deductions of the compiler from the statistics presented, and those attacking our railway methods, financial, administrational, or mechanical, can ask for no clearer statement of the road's side of the case.

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Table of Contents

	PAGE
The Armored Ships of the United States Navy.—1 illustration	321
Our Radium Resources.—By Charles L. Parsons	322
The Consumption of Paper	323
The 1913-14 Borel Monoplane, Military Type.—By John J. Ide.—2 illustrations	324
How a Basement Story was Added to a Mill.—By James Chittick.—2 illustrations	324
The Pyrophoric Alloy Industry.—By Geoffrey Martin.—2 illustrations	325
Heavy Oil as Fuel for Internal Combustion Engines.—By Irving C. Allen	326
Plants Cultivated at the Neolithic Epoch	327
Some Phases of the Illumination of Interiors.—By Preston S. Millar.—12 illustrations	328
Our Fighting Strength. Armored Ships of the United States Navy	331
Flavor of Butter Injured by Metals	334
What Are the Ten Greatest Inventions of the Age, and Why?—By "Idline" (Emil Schultze of Baltimore)	335
Book Notes	336